Draft U. S. Pacific Marine Mammal Stock Assessments: 2001

by

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PREFACE

Under the 1994 amendments to the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) are required to publish Stock Assessment Reports for all stocks of marine mammals within U.S. waters, to review new information every year for strategic stocks and every three years for non-strategic stocks, and to update the stock assessment reports when significant new information becomes available. This draft report presents revised stock assessments for 10 Pacific marine mammal stocks under NMFS jurisdiction. New information is indicated by redline font. Outdated information proposed for deletion is indicated by ~~strikeout font~~. The remaining 45 stocks assessments revised in 2000 will be reprinted in the final version of this report without revision. Stock Assessments for Alaskan marine mammals are published by the National Marine Mammal Laboratory (NMML) in a separate report.

The 10 revised stock assessments in this draft report include stocks studied by the Southwest Fisheries Science Center (SWFSC, La Jolla, California and Honolulu, Hawaii laboratories) and the National Marine Mammal Laboratory (NMML, Seattle, Washington). Staff of the National Marine Mammal Laboratory prepared the report on the Eastern North Pacific Southern Resident killer whale stock. Honolulu laboratory staff prepared the report on the Hawaiian monk seal. SWFSC, La Jolla Laboratory staff prepared stock assessments for the remaining 8 stocks. A summary table for these revised stock assessment reports is provided in Appendix 1. Information on the commercial fisheries that interact with these stocks is provided in Forney et al. (2000, Appendix 1).

New estimates of abundance are available for 9 stocks: California harbor seal (Channel Islands only), Hawaiian monk seal, northern and central California stocks of harbor porpoise, California coastal bottlenose dolphin, Eastern North Pacific southern resident killer whale, Eastern North Pacific humpback whale, and the California/Oregon/Washington sperm whale stock. New information on changes in the Hawaiian longline fishery is presented in the Hawaii false killer whale report. The stock of humpback whale previously referred to as the 'California/Oregon/Washington - Mexico stock' has been renamed the 'Eastern North Pacific' stock, reflecting increased knowledge of their range and movements.

Earlier versions of these stock assessment reports were reviewed by members of the Pacific and Alaska Scientific Review Groups; we thank them for their helpful comments. The authors also wish to thank those who provided unpublished data. Any omissions or errors are the sole responsibility of the authors.

This is a working document and individual stock assessment reports will be updated as new information becomes available and as changes to marine mammal stocks and fisheries occur. The authors solicit any new information or comments which would improve future stock assessment reports.

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Forney, K.A., J. Barlow, M.M. Muto, M. Lowry, J. Baker, G. Cameron, J. Mobley, C. Stinchcomb, and J.V. Carretta. 2000. U.S. Pacific Marine Mammal Stock Assessments: 2000. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-300. 276p.

Revised ~~12/15/2000~~ 4/26/2001

HARBOR SEAL (*Phoca vitulina richardsi*): California Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals (*Phoca vitulina*) are widely distributed in the North Atlantic and North Pacific. Two subspecies exist in the Pacific: *P. v. stejnegeri* in the western North Pacific, near Japan, and *P. v. richardsi* in the eastern North Pacific. The latter subspecies inhabits near-shore coastal and estuarine areas from Baja California, Mexico, to the Pribilof Islands in Alaska. These seals do not make extensive pelagic migrations, but do travel 300-500 km on occasion to find food or suitable breeding areas (Herder 1986; D. Hanan unpublished data). In California, approximately 400-500 harbor seal haulout sites are widely distributed along the mainland and on offshore islands, including intertidal sandbars, rocky shores and beaches (Hanan 1996).

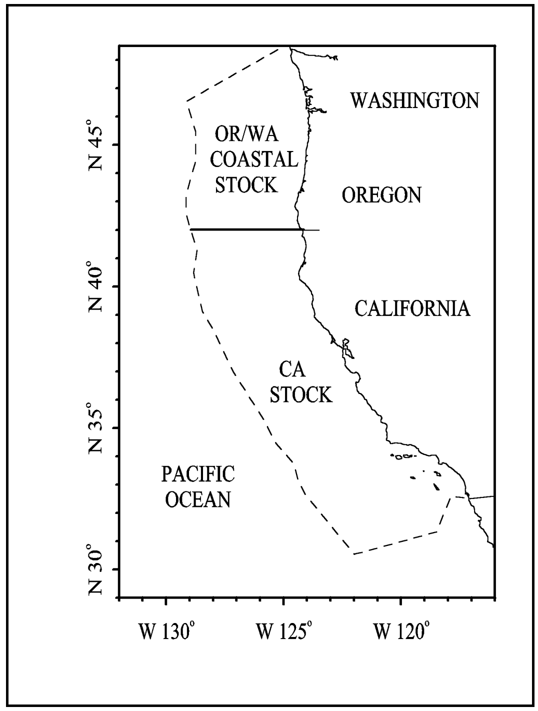

Figure 1. Stock boundaries for the California and Oregon/Washington coastal stocks of harbor seals. Dashed line represents the U.S. EEZ.

Within the subspecies *P. v. richardsi*, abundant evidence of geographic structure comes from differences in mitochondrial DNA (Huber et al. 1994; Burg 1996; Lamont et al. 1996), mean pupping dates (Temte 1986), pollutant loads (Calambokidis et al. 1985), pelage coloration (Kelly 1981) and movement patterns (Jeffries 1985; Brown 1988). LaMont (1996) identified four discrete subpopulation differences in mtDNA between harbor seals from Washington (two locations), Oregon, and California. Another mtDNA study (Burg 1996) supported the existence of three separate groups of harbor seals between Vancouver Island and southeastern Alaska. Although we know that geographic structure exists along an almost continuous distribution of harbor seals from California to Alaska, stock boundaries are difficult to draw because any rigid line is (to a greater or lesser extent) arbitrary from a biological perspective. Nonetheless, failure to recognize geographic structure by defining management stocks can lead to depletion of local populations. Previous assessments of the status of harbor seals have recognized 3 stocks along the west coast of the continental U.S.: 1) California, 2) Oregon and Washington outer coast waters, and 3) inland waters of Washington. Although the need for stock boundaries for management is real and is supported by biological information, the exact placement of a boundary between California and Oregon was largely a political/jurisdictional convenience. A small number of harbor seals also occur along the west coast of Baja California, but they are not considered to be a part of the California stock because no international agreements exist for the joint management of this species by the U.S. and Mexico. Lacking any new information on which to base a revised boundary, the harbor seals of California will be again treated as a separate stock in this report (Fig. 1). Other Marine Mammal Protection Act (MMPA) stock assessment reports cover the five other stocks that are recognized along the U.S. west coast: Oregon/Washington outer coastal waters, Washington inland waters, and three stocks in Alaska coastal and inland waters.

POPULATION SIZE

A complete count of all harbor seals in California is impossible because some are always away from the haulout sites. A complete pup count (as is done for other pinnipeds in California) is also not possible because harbor seals are precocious, with pups entering the water almost immediately after birth. Population size is estimated by counting the number of seals ashore during the peak haul-out period (the May/June molt) and by multiplying this count by the inverse of the estimated fraction of seals on land. Boveng (1988) reviewed studies estimating the proportion of seals hauled out to those in the water and suggested that a correction factor for harbor seals is likely to be between 1.4 and 2.0. Huber (1995) estimated a mean correction factor of 1.53 (CV=0.065) for harbor seals in Oregon and Washington during the peak pupping season. Hanan (1996) estimated that 83.3% (CV=0.17) of harbor seals haul out at some time during the day during the May/June molt, and he estimated a correction factor of 1.20 based on those data. Neither correction factor is directly applicable to an aerial photographic count in California: the 1.53 factor was measured at the wrong time of year (when fewer seals are hauled out) and in a different area and the 1.20 factor was based on the fraction of seals hauled out over an entire 24 hr day (correction factors for aerial counts should be based on the fraction of seals hauled out at the time of the survey). Hanan (pers. comm.) revised his haul-out correction factor to 1.3 by using only those seals hauled out between 0800 and 1700 which better corresponds to the timing of his surveys. Based on the most recent harbor seal counts (23,302 in May/June 1995, Hanan 1996) and Hanan's revised correction factor, the harbor seal population in California is estimated to number 30,293. A harbor seal count in California was attempted in 1999, but was not successful due to bad weather and camera failure (Hanan, pers. comm.). ~~Another survey is planned for 2000.~~ An aerial survey in May/June 2000 was successful in obtaining a new haul-out estimate for the Channel Islands in southern California (Fig. 2), but weather and other factors precluded a complete survey of the entire state.

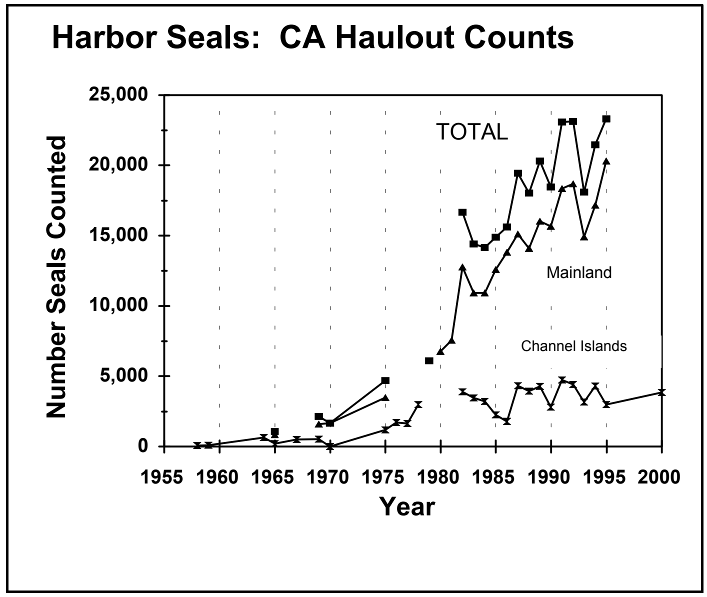

Figure 2. Harbor seal haulout counts in California during May/June (Hanan 1996; R. Read, CDFG unpubl. data).

Minimum Population Estimate

Because of the way it was calculated (based on the fraction of seals hauled out at any time during a 24 hr day), Hanan's (1996) correction factor of 1.2 can be viewed as a minimum estimate of the fraction hauled out at a given instant. A population size estimated using this correction factor provides a reasonable assurance that the true population is greater than or equal to that number, and thus fulfills the requirement of a minimum population estimate. The minimum size of the California harbor seal population is therefore 27,962.

Current Population Trend

Harbor seal counts have continued to increase except during El Niño events (eg. 1992-93) (Fig. 2). The net production appears, however, to be slowing in California (Fig. 3) and in Oregon and Washington (see separate Stock Assessment Report).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A realized rate of increase was calculated for the 1982-1995 period by linear regression of the natural logarithm of total count versus year. The slope this regression line was 0.035 (s.e.=0.007) which gives an annualized growth rate estimate of 3.5%. The current rate of net production is greater than this observed growth rate because fishery mortality takes a fraction of the net production.

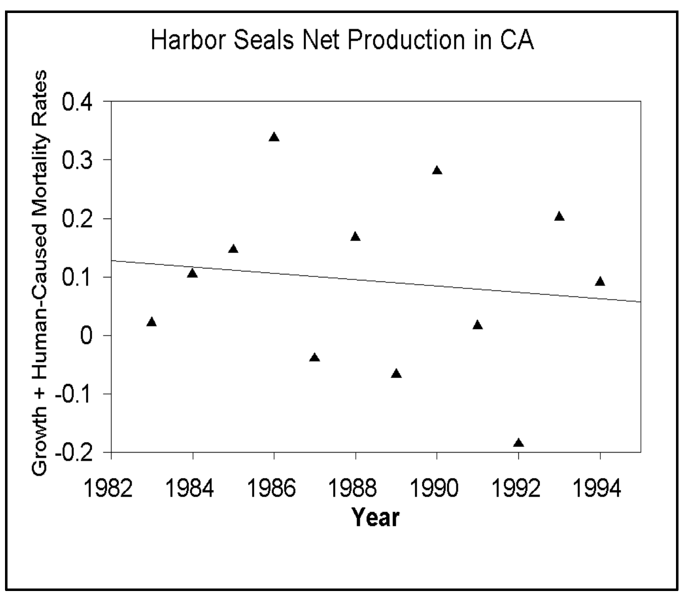

Figure 3. Net production rates and regression line estimated from haulout counts and fishery mortality.

Annual gillnet mortality may have been as high as 5-10% of the California harbor seal population in the mid-1980s; a kill this large would have depressed population growth rates appreciably. Net productivity was therefore calculated for 1980-1994 as the realized rate of population growth (increase in seal counts from year *i* to year *i*+1, divided by the seal count in year *i*) plus the human-caused mortality rate (fishery mortality in year *i* divided by population size in year *i*). Between 1983 and 1994, the net productivity rate for the California stock averaged 9.2% (Fig. 3). A regression shows a decrease in net production rates, but the decline is not statistically significant. Maximum net productivity rates cannot be estimated because measurements were not made when the stock size was very small.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (27,962) times one half the default maximum net productivity rate for pinnipeds (½ of 12%) times a recovery factor of 1.0 (for a stock of unknown status that is growing, Wade and Angliss 1997), resulting in a PBR of 1,678.

Table 1. Summary of available information on the mortality and serious injury of harbor seals (California stock) in commercial fisheries that might take this species (NMFS 1995; Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999; 2000). n/a indicates that data are not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1994-98~~ 1995-99	observer data	12-23%	0	0,0,0,0,0	0[1]
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	~~1991~~ ~~1992~~ ~~1993~~ ~~1994~~ 1995 1996 1997 1998 1999	~~observer data~~ extrapo-lated estimate observer data	~~9.8%~~ ~~12.5%~~ ~~15.4%~~ ~~7.7%~~ 0.0% 0.0% 0.0% 0.0% 4.0%[3]	~~42~~ ~~90~~ ~~71~~ ~~23~~ - - - - 57	~~601 (0.23)~~ ~~1,204 (0.47)~~ ~~475 (0.13)~~ ~~227 (0.33)~~ 228 (0.13)[2] 296 (0.08)[2] 349 (0.08)[2] 392 (0.10)[2] 662 (0.10)[3]	~~n/a~~ 662
CA, OR, and WA salmon troll fishery	1990-92	logbook data	-		Avg. Annual take = 7.33	n/a
CA herring purse seine fishery	1990-92	logbook data	-		Avg. Annual take = 0	n/a
CA anchovy, mackerel, and tuna purse seine fishery	1990-92	logbook data	-		Avg. Annual take = 0.67	n/a
WA, OR, CA groundfish trawl	1991-95	observer data	54-73%	0	0,0,0,0,0	0
CA squid purse seine fishery	1990-92	logbook data	-		Avg. Annual take = 0	n/a
(unknown net and hook fisheries)	1995-98	stranding data		17		4
Total annual takes						~~n/a~~ 666

[1] Only 1997-98 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).
[2] The CA set gillnets were not observed ~~after 1994~~ from 1995-98; mortality was extrapolated from effort estimates and previous entanglement rates.
[3] Set gillnet observer coverage in 1999 was limited to Monterey Bay fishing effort only. Mortality in other areas was extrapolated from 1999 effort estimates and 1991-94 entanglement rates.

HUMAN-CAUSED MORTALITY

Historical Takes

Prior to state and federal protection and especially during the nineteenth century, harbor seals along the west coast of North America were greatly reduced by commercial hunting (Bonnot 1928, 1951; Bartholomew and Boolootian 1960). Only a few hundred individuals survived in a few isolated areas along the California coast (Bonnot 1928). In the last half of this century, the population has increased dramatically.

Fishery Information

A summary of known fishery mortality and injury for this stock of harbor seals is given in Table 1. More detailed information on these fisheries is provided in Forney et al. (2000, Appendix 1). Because the vast majority of harbor seal mortality in California fisheries occurs in the set gillnet fishery, because that fishery has undergone dramatic reductions and redistributions of effort, and because ~~that~~ the entire fishery has not been observed since 1994, average annual mortality cannot be accurately estimated for the recent years (1995-~~98~~1999). Rough estimates for 1995-~~1998~~1999 have been made by extrapolation of prior kill rates using recent effort estimates (Table 1). Preliminary gillnet observations from April to September 1999 included 47 harbor seals in 24.6% of the sets for a rough extrapolated estimate of 191 mortalities in this half-year period. Stranding data reported to the California Marine Mammal Stranding Network in 1995-98 include harbor seal deaths and injuries caused by hook-and-line fisheries (17 deaths, 4 injuries) and gillnet fisheries (1 death, 2 injuries).

Other Mortality

The California Marine Mammal Stranding database maintained by the National Marine Fisheries Service, Southwest Region, contains the following records of human-related harbor seal mortalities and injuries in 1995-~~98~~99: (1) boat collision (~~10~~11 mortalities, 2 injuries), (2) entrainment in power plants (~~20~~24 mortalities), and (3) shootings (~~9~~11 mortalities).

STATUS OF STOCK

A review of harbor seal dynamics through 1991 concluded that their status relative to OSP could not be determined with certainty (Hanan 1996). They are not listed as "endangered" or "threatened" under the Endangered Species Act nor as "depleted" under the MMPA. Total fishing mortality cannot be accurately estimate for recent years, but extrapolations from past years and preliminary data for 1999 indicate that fishing mortality is less than the calculated PBR for this stock (1,678), and thus they would <u>not</u> be considered a "strategic" stock under the MMPA. The average rate of incidental fishery mortality for this stock is likely to be greater than 10% of the calculated PBR; therefore, fishery mortality cannot be considered insignificant and approaching zero mortality and serious injury rate. The population appears to be growing and the fishery mortality is declining. There are no known habitat issues that are of particular concern for this stock. Two unexplained harbor seal mortality events occurred in Point Reyes National Park involving at least 90 seals in 1997 and 16 seals in 2000. Necropsy of 3 seals in 2000 showed severe pneumonia; tests for morbillivirus were negative, but attempts are being made to identify another virus isolated from one of the three (F. Gulland, pers. comm.). All west-coast harbor seals that ~~were~~ have been tested for morbilliviruses were found to be seronegative, indicating that this disease is not endemic in the population and that this population is extremely susceptible to an epidemic of this disease (Ham-Lammé et al. 1999).

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HAWAIIAN MONK SEAL (*Monachus schauinslandi*)

STOCK DEFINITION AND GEOGRAPHIC RANGE

Hawaiian monk seals are distributed throughout the Northwestern Hawaiian Islands (NWHI) in six main reproductive subpopulations at French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll. Small subpopulations also exist at Necker Island and Nihoa Island ~~are maintained by immigration~~, and a few seals are distributed throughout the main Hawaiian Islands. Studies of Hawaiian monk seals have focused on their abundance and behavior on land during the reproductive season (spring and summer). Expanded research is underway, but currently the pelagic distribution and behavior of monk seals cannot be fully characterized.

In the last two centuries, the species has experienced two major declines which~~, presumably,~~ may have severely reduced its genetic variation. The tendency for genetic drift may have been (and continue to be) relatively large, due to the small size of different island/atoll subpopulations. However, 10-15% of these seals migrate among the subpopulations (Johnson and Kridler 1983; National Marine Fisheries Service [NMFS] unpubl. data) and, to some degree, this movement should counter the development of separate genetic stocks. Genetic variation among the different island populations is low (Kretzmann et al., 1997).

Demographically, the different island subpopulations have exhibited considerable independence. For example, abundance at French Frigate Shoals grew rapidly during the 1950s to the 1980s, while other subpopulations declined rapidly. However, variation in past population trends may be partially explained by changes in the level of human disturbance (Gerrodette and Gilmartin 1990). Current demographic variability among th~~e island~~ subpopulations probably reflects a combination of different recent histories and varying environmental conditions. While research and recovery activities focus on the problems of single island/atoll subpopulations, the species is managed as a single stock.

POPULATION SIZE

Abundance of the main reproductive subpopulations is best estimated using the number of seals identified at each site. Individual seals are identified by applied flipper-tags and bleach-marks, and natural features such as scars and distinctive pelage patterns. Flipper-tagging of weaned pups began in the early 1980s, and the majority of the seals in the main reproductive subpopulations can be identified on the basis of those tags. In 1999~~8~~, identification efforts were conducted during two- to five-month studies at all main reproductive sites except Midway Atoll, where the study period was 12 months. A total of ~~1308~~1344 seals (including ~~246~~244 pups) were observed at the main reproductive subpopulations in 1999~~8~~ (Johanos and Baker, 2001 ~~NMFS, unpubl. data~~). Removal analyses in previous years and sighting probability calculations suggest that 90% or more of the seals were identified at each site (i.e., any negative bias should be less than 10%).

Monk seals also occur at Necker and Nihoa Islands, where ~~several repeated~~ counts are only conducted once or a few times in a single year ~~were last conducted in 1993~~. ~~Single counts in subsequent years do not indicate abundance at those sites has changed appreciably. The 1993 studies were not of sufficient duration to identify all individuals, so local~~ A~~a~~bundance is ~~best~~ estimated by correcting the mean of all beach counts accrued over the past five years. ~~and assuming that abundance at these sites has not changed. In 1993, m~~ The mean (±SD) of all counts (excluding pups) conducted during the five years ending in 1999 were ~~22~~18.4 (±~~5.2~~9.6) at Necker Island and ~~18~~20 (±~~7.3~~4.9) at Nihoa Island (NMFS unpubl. data ~~Ragen and Finn 1996~~).

The observed relationship between mean counts and total abundance at the reproductive sites indicates that the total abundance can be estimated by multiplying the mean count by a correction factor (±SE) of 2.89 (±0.06, NMFS unpubl. data). Resulting estimates (plus the average number of pups known to have been born in the five years ending in 1999 ~~1993~~) are ~~65~~54.2 (±~~15.1~~27.7) at Necker Island and ~~56~~61.8 (±~~21.1~~14.2) at Nihoa Island.

Finally, a small number of seals are distributed throughout the main Hawaiian Islands. These include an unknown number of seals, which naturally occur in the main Hawaiian Islands. In addition, twenty-one seals were released around these islands in 1994. All but two were subsequently resighted near their respective release sites, but their survival to ~~1998~~1999 is unknown, because there is no formal resighting effort in the main Hawaiian Islands. The first systematic survey of Hawaiian monk seals in the main Hawaiian Islands was conducted in 2000, however the data have not been thoroughly analyzed to date. In previous Stock Assessment Reports, abundance in the main Hawaiian Islands had been estimated at 40 seals with a coefficient of variation of 10 seals. Because the recent survey numbers are not analyzed, this previous estimate will be used for 1999. ~~Sporadic reports indicate total abundance on the main~~

~~Hawaiian Islands (including seals released in 1994) may be as high as 40 seals.~~

Minimum Population Estimate

The total number of seals identified at the main reproductive sites is the best estimate of minimum population size at those sites (i.e., ~~1308~~1344 seals). Minimum population sizes for Necker and Nihoa Islands (based on the formula provided by Wade and Angliss (1997)) are ~~54~~36 and ~~41~~51, respectively. If it is assumed that the abundance estimate for seals in the main Hawaiian Islands is, as described above ~~say~~, 40 ±10 seals (i.e., a coefficient of variation of 0.25), then an estimate of the minimum population size in the main Islands is 33 seals. The minimum population size for the entire stock (species) is the sum of these estimates, or ~~1436~~1464 seals.

Current Population Trend

Between 1958 and 1999~~8~~, the total of mean non-pup beach counts at the main reproductive subpopulations declined by approximately 60%. From 1985 to ~~1998~~1999, the average rate of decline was approximately 3% yr^{-1}, although ther~~e~~ counts have been stable ~~has been little change~~ since 1993 (Fig. 1). Further decline is likely, due to extremely high juvenile mortality and an imminent drop in reproductive recruitment in the largest subpopulation (French Frigate Shoals).

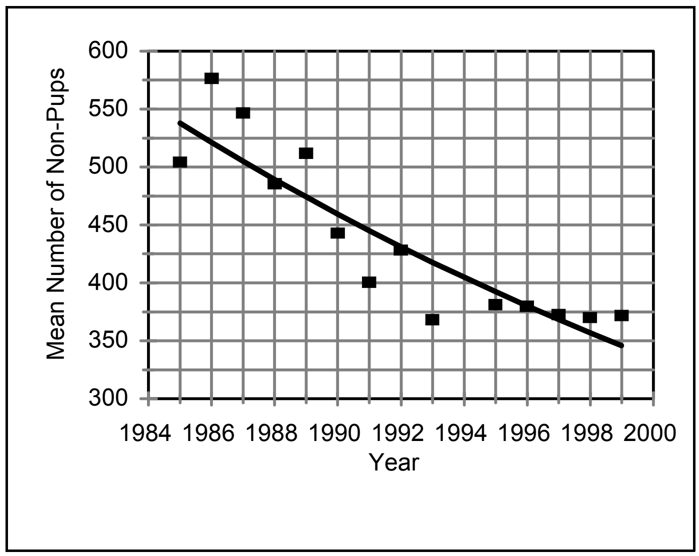

Figure 1. Mean beach counts of Hawaiian monk seals (non-pups) at the main reproductive rookeries (excluding Midway Atoll), 1985-99~~8~~.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Assuming mean beach counts are a reliable index of total abundance, then the current net productivity rate for this species is -0.03 yr^{-1} (loglinear regression of beach counts of non-pups, 1985-~~98~~99; R^2 = 0.82, P<0.001). This trend is largely due to a severe decline at French Frigate Shoals, where non-pup beach counts decreased by 60% between 1989 and 1999~~8~~. Populations at Laysan and Lisianski Islands ~~have not grown, but~~ have remained relatively stable since approximately 1990.

Contrary to trends at the above sites, the subpopulation at Kure Atoll has grown at ca. 5% yr^{-1} since 1983 (loglinear regression of beach counts, 1983-~~98~~99; R^2 = 0.~~79~~ 82, P<0.001), due largely to decreased human disturbance and introduced females. The subpopulation at Pearl and Hermes Reef has grown at approximately ~~7~~ 6% yr^{-1} since 1983 (loglinear regression of beach counts, 1983-19~~98~~99; R^2 = 0.8~~1~~2, P<0.001). Growth of the Pearl and Hermes population may be slowing slightly, as previous to 1999 the growth rate averaged 7%yr^{-1} (Forney et al. 2000). This~~e~~ latter annual growth rate is the best indicator of the maximum net productivity rate (R_{max}) for this species. Finally, the small subpopulation at Midway Atoll continues to ~~is~~ show~~ing~~ signs of ~~incipient~~ recovery.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~1436~~1464) times one half the ~~default~~ maximum net growth rate for this stock (½ of 7%) times a recovery factor of 0.1 (for an endangered species, Wade and Angliss 1997), resulting in a PBR of 5 monk seals per year. ~~However, the Endangered Species Act takes precedence in the management of this species and, under the Act, allowable take is zero.~~

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Human-related mortality has caused two major declines of the Hawaiian monk seal. In the 1800s, this species was decimated by sealers, crews of wrecked vessels, and guano and feather hunters (Dill and Bryan 1912; Wetmore 1925; Clapp and Woodward 1972). Several subpopulations may have been driven extinct; for example, no seals were seen at Midway Atoll during a 14-month period in 1888-89, and only a single seal was seen during three months of observations at Laysan Island in 1912-13 (Bailey 1952). A survey in 1958 indicated at least partial recovery of the species in the first half of this century (Rice 1960). However, subsequent surveys revealed that all subpopulations except French Frigate Shoals declined severely after the late 1950s (or earlier). This second decline has not been explained at Pearl and Hermes Reef, or Lisianski and Laysan Islands. At Kure Atoll, Midway Atoll, and French Frigate Shoals, trends appear to have been determined by the pattern of human disturbance from military or U.S. Coast Guard activities. Such disturbance caused pregnant females to abandon prime pupping habitat and nursing females to abandon their pups (Kenyon 1972; Gerrodette and Gilmartin 1990). The result was a decrease in pup survival, which led to poor reproductive recruitment, low productivity, and population decline.

Since 1979, disturbance from human activities on land has been limited primarily to Kure and Midway Atolls. The U.S. Coast Guard LORAN station at Kure Atoll was closed in 1992 and vacated in 1993. The U.S. Naval Air Facility at Midway was closed in 1993 and, following clean-up and restoration activities, jurisdiction was transferred in 1997 to the U.S. Fish and Wildlife Service, which manages the atoll as a National Wildlife Refuge. The refuge station and the atoll runway are maintained cooperatively with a commercial aircraft company, which supports its Midway operations, in part, by establishing a tourism center at the site. Strict regulations have been established to prevent further human disturbance of the seals, but careful monitoring of human activities will be essential to ensure that the regulations are both adequate and observed (see Habitat Issues below).

In addition to disturbance on land, disturbance at sea (e.g., direct and indirect fisheries interactions) may also impede recovery. As described below, however, the possible types of disturbance at sea cannot yet be characterized or quantified.

Fishery Information

Detrimental fishery interactions with monk seals fall into four categories: operations/gear conflict, entanglement in fisheries debris (most of which likely originate in North Pacific fisheries outside the NWHI), seal consumption of potentially toxic discards, and competition for prey. Since 1982, a total of nine fishery-related monk seal deaths have been recorded, including six from entanglement in fisheries debris (Henderson 1990; NMFS, unpubl. data), one from entanglement in the bridle rope of lobster trap (1986; NMFS, unpubl. data), one from entanglement in an illegally set gill net off the western shore of Oahu (1994; NMFS, unpubl. data), and one from ingestion of a recreational fish hook and probable drowning off the island of Kauai (1995; NMFS, unpubl. data). In addition, 17 other seals have been observed with embedded fish hooks, 23 seals have been observed with wounds suspected to have resulted from interactions with fisheries, and ~~172~~197 cases of seals entangled in fishing gear or other debris have been observed through 1999~~8~~ (NMFS, unpubl. data). Importantly, the majority of these deaths and injuries have been observed incidentally during land-based research or other activities; monk seal/fisheries interactions need to be monitored to assess the rate of fisheries-related injury or mortality for this species.

Four fisheries interact with Hawaiian monk seals. The NWHI lobster fishery began in the late 1970s, and developed rapidly in the early 1980s (Polovina, 1993). Annual landings peaked in 1985 (1.92 million lobsters) and 1986 (1.69 million lobsters; Haight and DiNardo 1995). Thereafter, the fishery declined and was closed temporarily in 1993 due to low spawning stock biomass of spiny lobster. Since 1994, landings remained lower than in the mid- to late 1980s, while catch of slipper lobster has increased in some areas. The number of vessels in the fishery increased from four in 1983 to 17 in 1985, then ranged from 0-12 during 1991-1999~~8~~, with ~~five~~ six vessels participating in 1999~~8~~ (Dollar 1995; DiNardo et al. 1998; Kawamoto and Pooley, 2000). Historically, both effort and landings have been concentrated at Gardner Pinnacles, Maro Reef, Necker Island, and St. Rogatien Bank (Clarke and Todoki 1988; Polovina and Moffitt 1989). However, spatial management of the NWHI lobster fishery began in 1998 with the formation of four management areas: Necker Island (Area 1), Maro Reef (Area 2), Gardner Pinnacles (Area 3), and all remaining banks from Nihoa Island in the east to Kure Atoll in the west (~~called~~ Area 4). This approach was adopted in an effort to prevent local depletion of lobster stocks at Necker Island, Maro Reef, and Gardner Pinnacles and to disperse fishing effort, which in recent years had~~s~~ been limited to Necker Island and Maro Reef. As a result of the new management approach, ~~48,200~~ 59,500 lobsters, comprising ~~21~~ 25% of the total catch, were taken from Area 4, which, until 1998, had not been fished since the early 1990's (DiNardo et al.1998; Kawamoto and Pooley 2000). Summaries of catch by area, trends and available data on bycatch are published in annual reports, the most recent being Kawamoto and Pooley (2000). A significant portion of the Area 4 catch in 1999~~8~~ was taken at locations where monk seal subpopulations occur. Neither incidental mortality nor serious injury have been observed by NMFS observers of the lobster fishery through 1999~~8~~. As was noted, one mortality was documented in 1986; a monk seal drowned after becoming entangled in the bridle rope of an actively fishing lobster trap near Necker Island. The potential for indirect interaction due to competition for prey is being investigated (see Habitat Issues below).

NMFS closed the Northwestern Hawaiian Islands lobster fishery for the year 2000 season due to uncertainty in the estimates of biomass. The Agency intends to keep the fishery closed in Areas 1-3 through the year 2001 and in Area 4 through the year 2002. The Agency is preparing an Environmental Impact Statement (EIS) for the fishery and ESA Section 7 consultation will be conducted prior to any opening the fishery. Furthermore, President Clinton's Executive Order (1/18/2001) creating the Northwest Hawaiian Islands coral reef ecosystem reserve also precludes much if not all lobster fishing in the NWHI.

~~A noteworthy event associated with the lobster fishery was the 16 October 1998 grounding of a transiting lobster vessel (Paradise Queen II) on the fringing reef at Kure Atoll, near Green Island. As a result of the shipwreck, approximately 4,000 gallons of diesel fuel spilled but no significant direct impact from the fuel was detected on monk seals or other wildlife in the vicinity. The hull of the vessel has since broken up, and pieces remain scattered on the reef and on shore. Trap line and several hundred lobster traps equipped with rope bridles were lost. Some of these have been recovered and removed after washing ashore. Salvage of the Paradise Queen II and her gear were halted due to inclement weather and insufficient funding. This vessel grounding represents a direct threat to monk seals via potential entanglement in derelict line and lobster traps, and entrapment in pieces of the ship's hull. Most of the traps and line which washed ashore have since been removed from the atoll as part of an ongoing marine debris mitigation effort. Indirect impacts on monks seals via habitat degradation is another threat, as the vessel damaged the coral reef and lost lobster traps were observed to be ghost fishing for reef organisms that monk seals may prey upon.~~

On 16 October 1998 the *Paradise Queen II*, a lobster fishing vessel, ran aground on the eastern edge of Kure Atoll. In 1999, large portions of the hull and wheel house still remained on the reef, smaller structural pieces had washed ashore, and a large portion of the main deck had come to rest on Green Island. Monk seals occasionally hauled out on this deck. During an initial clean up effort soon after Paradise Queen II ran aground, accessible hazardous material and lobster traps were removed from the marine environment. Subsequently, more traps washed up on shore and were stacked on Green Island to await removal. Presently, all recovered traps (totaling several hundred) have been removed from the island. It is not known whether any more lobster traps remain in the waters of Kure Atoll.

The NWHI bottomfish fishery also interacts with monk seals. This fishery occurred at low levels (< 50 t per year) until 1977, steadily increased to 460 metric tons in 1987, then dropped to 284 metric tons in 1988, and varied from 137 - 201 metric tons per year from 1989-1999~~8~~ (Kawamoto 1995; Moffitt ~~Kawamoto~~, pers. comm.). The number of vessels rose from 19 in 1984 to 28 in 1987, and then varied from 10 to 17 in 1988 through 1999~~8~~ (Kawamoto 1995; Moffitt ~~Kawamoto~~, pers. comm.). Currently, the bottomfish fishery remains open, although its area of operation has been substantially restricted by President Clinton's Executive Order (1/18/2001). The Agency is preparing an Environmental Impact Statement and a Section 7 Biological Opinion on the operation of the fishery. The fishery was monitored by observers from October 1990 to December 1993 (ca. 13% coverage), but is currently monitored by the State of Hawaii using logbooks. However, the State logbook does not include information on protected species and, therefore, the nature and extent of interactions with monk seals cannot be assessed. Nitta and Henderson (1993) evaluated observer data from 1991-92 and reported an interaction rate of one event per 34.4 hours of fishing, but they do not provide a confidence interval for their estimate. The authors documented one seal found with a bottomfish hook in her mouth at French Frigate Shoals, observer reports of seals taking bottomfish and bait off fishing lines, and observer reports of seals attracted to discarded bottomfish bycatch, which may contain ciguatoxin or other biotoxins. Injury or mortality resulting from hooking or consumption of toxic discards cannot be determined with the available data. The ecological effects of this fishery on monk seals (e.g., competition for prey or alteration of prey assemblages by removal of key predator fishes) are unknown. However, published studies on monk seal prey selection based upon scat/spew analysis and seal-mounted video, rarely revealed evidence that monk seals fed on families of bottomfish which contain commercial species (many hard parts of scats and spews were identified only to the level of family; Goodman-Lowe 1998, Parrish et al. 2000). Fatty acid signature analysis is inconclusive regarding the importance of commercial bottomfish in the monk seal diet, but this methodology continues to be pursued.

Table 1. Summary of incidental mortality of Hawaiian monk seals due to commercial and recreational fisheries since 1990 and calculation of annual mortality rate. n/a indicates that sufficient data are not available.

Fishery Name	Years	Range of # of vessels per year	Date type	Range of observer coverage	Total observed mort.	Estimated mort. (in given years)	Mean annual mort.
NWHI lobster	91-99~~8~~	0-12	Observer Log book	0-100%	0	n/a	n/a
NWHI Bottomfish	91-99~~8~~	12-17	n/a	n/a	n/a	n/a	n/a
Pelagic longline	91-99~~8~~	103-141	Observer Log book	4-5%	0	n/a	n/a
Recreational	91-95	n/a	n/a	n/a	2[†]	n/a	n/a

[†] Data collected incidentally.

A third fishery in which past interactions with monk seals were documented ~~is~~ was the pelagic longline fishery. This fishery targets swordfish and tunas, primarily, and does not compete with Hawaiian monk seals for prey. The fishery began in the 1940s, and operated at a relatively low level (< 5000 t per year) until the mid-1980s. In 1987, 37 vessels participated, but by 1991, the number had grown to 141 (Ito, 1995). The number of active vessels ranged from 103-141 during 1991-99~~8~~. Entry is currently limited to a maximum of 164 vessels (Ito and Machado, 1999). Total landings ranged from 8,100-13,000 metric tons during 1991-199~~8~~ (Ito, pers. comm.). While most of the fishery has operated outside of the NWHI Exclusive Economic Zone, the rapid expansion raised concerns about the potential for interactions with protected species, including the monk seal. Evidence of interactions began to accumulate in 1990, including three hooked seals and 13 unusual seal wounds thought to have resulted from interactions. In response, NMFS established a permanent Protected Species Zone extending 50 nautical miles around the NWHI and the corridors between the islands in October 1991. Subsequent shore-based observations of seals have found no further evidence of ~~suggest that~~ interactions with the longline fishery ~~decreased substantially~~ after establishment of the Protected Species Zone. At present, interactions with protected species are assessed using Federal logbooks and observers (4-5% coverage), which may lack sufficient statistical power to estimate monk seal mortality/serious injury rates from longline interactions. However, since 1991, there have been no observed or reported interactions of this fishery with monk seals.

There have also been interactions between recreational fisheries and monk seals in both the NWHI and around the main Hawaiian Islands. At least three seals have been hooked at Kure Atoll, but such incidents should no longer occur at this site because the atoll was vacated by the U.S. Coast Guard in 1993. In the main Hawaiian Islands, one seal was found dead in an offshore (non-recreational) gillnet in 1994 and a second seal was found dead with a recreational hook lodged in its esophagus. At least seven other seals have been hooked. Three of these incidents involved hooks used to catch ulua (Caranx spp.). One hooked seal had been translocated from Laysan Island to the main Hawaiian Islands in July 1994. The recent establishment of sport fishing at Midway clearly increases the potential for monk seals to be harmed by hooks at that site.

Recent interest in the harvest of precious coral in the NWHI represents a potential for future interactions with monk seals. The impact that removal of precious corals might have on monk seal prey resources and foraging habitat is not known. However, recent studies of seals with satellite transmitters and surveys using manned submersibles indicate that some monk seals forage at patches of precious gold corals occurring over 500m in depth (Parrish, pers. comm.). Recruitment of gold coral is very slow (perhaps on the order of 100 years), so there is concern that harvesting could have a long term impact on monk seal foraging habitat. As a result, the Western Pacific Regional Fisheries Management Council has recommended regulations to suspend or set to zero annual quotas for gold coral harvest at specific locations until information on impacts of such harvests on monk seal foraging habitat become available.

Fishery Mortality Rate

Because monk seals continue to die as a result of entanglement in North Pacific fishing debris (likely originating from various countries) and data are unavailable to assess interaction with specific fisheries, one must conclude that the total fishery mortality and serious injury for this stock is greater than ~~1) zero allowable take under the Endangered Species Act and 2)~~ 10% of the calculated PBR. Therefore, total fishery mortality and serious injury can not be considered to be insignificant and approaching a rate of zero.

Direct fishery interactions with this species remain to be thoroughly evaluated and, therefore, the information above represents only the observed level of interactions. Without further study, an accurate estimate cannot be determined. In addition, interactions may be indirect (i.e., involving competition for prey or consumption of discards from the bottomfish fishery) and, to date, the extent or consequences of such indirect interactions remain the topic of ongoing investigation.

Other Mortality

Since 1982, 22 seals died during rehabilitation efforts; additionally, two died in captivity, two died when captured for translocation, one was euthanized (an aggressive male known to cause mortality), three died during captive research and three died during field research.

Seals have also died after encounters with marine debris from sources other than fisheries. In 1986, a weaned pup died at East Island, French Frigate Shoals, after becoming entangled in wire left when the U.S. Coast Guard abandoned the island three decades earlier. In 1991, a seal died after becoming trapped behind an eroding seawall on Tern Island, French Frigate Shoals. This seawall continues to erode and poses an ongoing threat to the safety of seals and other wildlife.

The only documented case of illegal killing of an Hawaiian monk seal occurred when a resident of Kauai killed an adult female in 1989.

Other sources of mortality which are (or may be) impeding the recovery of this subpopulation include single and multiple male aggression (mobbing), shark~~s~~ predation, poisoning by ciguatoxin or other biotoxins, and disease/parasitism. ~~Mobbing occurs~~ W~~w~~hen multiple males attempt to mount and mate with an adult female or immature animal of either sex, ~~often leading to the~~ injury or death of the attacked seal often results. Since 1982, at least ~~66~~67 seals have died or disappeared after suffering multiple male aggression ~~being mobbed~~. The resulting increase in female mortality appears to have been a major impediment to recovery at Laysan and Lisianski Islands. Multiple male aggression ~~Mobbing~~ has also been documented at French Frigate Shoals, Kure Atoll, and Necker Island. ~~The primary cause of~~ Multiple male aggression ~~mobbing~~ is thought to be related to an imbalance in the adult sex ratio, with males outnumbering females. In 1994, 22 adult males were removed from Laysan Island, and only ~~two~~ three seals are thought to have died from multiple male aggression ~~mobbing~~ at this site since their removal (1995-99~~8~~). Such imbalances in the adult sex ratio are more likely to occur when populations are reduced (Starfield et al. 1995).

In addition to mobbing, aggressive attacks by single adult males have resulted in several monk seal mortalities. This was most notable at French Frigate Shoals in 1997, where at least 8 pups died as a result of adult male aggression. Many more pups were likely killed in the same way but the cause of their deaths could not be confirmed. Two males who had been known to kill pups in 1997 were observed exhibiting aggressive behavior toward pups at the beginning of the 1998 pupping season. These two males were translocated to Johnston Atoll, 870 km to the southwest. Subsequently, mounting injury to pups have decreased~~ and survival to weaning in 1998 was markedly higher than in 1997~~.

The incidence of shark-related injury and mortality may have increased in the late 1980s and early 1990s at French Frigate Shoals, but such mortality was probably not the primary cause of the decline at this site (Ragen 1993). However, indications are that shark predation has accounted for a significant portion of pup mortality in the last few years. At French Frigate Shoals in 1999, 17 pups were observed injured by large sharks, and at least 3 were confirmed to have died from shark predation (Johanos and Baker, 2001). Assigning cause of death to shark predation is problematic, as predation events are rarely observable. However, it is believed that as many as 25 pups of a total 92 born at French Frigate Shoals in 1999 were killed by sharks. The potential causes of high pup mortality, including shark predation, disease, male aggression and food limitation are currently being investigated at French Frigate Shoals. Poisoning by ciguatoxin or related toxins is suspected as the primary cause of the Laysan die-off in 1978, and may have contributed to the high mortality of juvenile seals translocated to Midway Atoll in 1992 and 1993. While virtually all wild monk seals carry parasites after they begin to forage, the role of parasitism in monk seal mortality is unknown. The effect of disease on monk seal demographic trends is also uncertain.

STATUS OF STOCK

In 1976, the Hawaiian monk seal was designated depleted under the Marine Mammal Protection Act of 1972 and as endangered under the Endangered Species Act of 1973. The species is assumed to be well below its optimum sustainable population (OSP) and, since 1985, has declined approximately 3% per year. Therefore, the Hawaiian monk seal is characterized as a strategic stock.

Habitat Issues

Available data indicate that the substantial decline at French Frigate Shoals was to some degree attributable to lack of available prey and subsequent emaciation and starvation. The two leading hypotheses to explain the lack of prey are 1) the local population reached its carrying capacity in the 1970s and 1980s, and essentially diminished its own food supply, and 2) carrying capacity was simultaneously reduced by changes in oceanographic conditions and a resulting decrease in productivity (Polovina et al. 1994; Craig and Ragen 2000;). Thus, this subpopulation may have significantly exceeded its carrying capacity, leading to a catastrophic increase in juvenile mortality. In addition, available prey also may have been reduced by competition with the NWHI lobster fishery. Monk seals forage at the four main banks where the fishery has primarily operated: Maro Reef, Gardiner Pinnacles, St. Rogatien Bank, and Necker Island. In 1998, the fishery expanded into areas where monk seal breeding populations are concentrated within the fishery's Area 4. Thus, competition for prey is under investigation. This potential for competition cannot yet be determined, however, because it is not known if lobster is an important component of the monk seal diet. Preliminary research indicates that lobster have identifiable fatty acid signatures, which will potentially make possible an assessment of its importance in the monk seal diet. This promising area of research is being actively pursued.

A second important habitat issue is the management of human activities at Midway Atoll. Historically, human activities have led to the near extinction of the resident monk seal population at Midway both in the late 1800s, and again in the 1960s. The seal population failed to recover in the 1970s and 1980s, but is finally beginning to show some signs of growth due to immigration from nearby sites. Management jurisdiction of Midway Atoll has been transferred from the U.S. Navy to the Fish and Wildlife Service. The Fish and Wildlife Service maintains a refuge station at Midway Atoll by cooperating with a commercial aircraft company that uses the runway on Sand Island (the largest island at Midway Atoll), and support its operations, in part, by establishing an on-site eco-tourism destination. Tourist activities include a range of land-based and marine recreational activities (e.g., scuba diving and sport fishing), as well as harbor services to visiting vessels. As the tourism venture develops, so does a potential conflict of interest. The economic success of the venture may depend on the nature and variety of human activities or privileges allowed at the site. Importantly, those activities that are intended to enhance the Midway experience may be disruptive or detrimental to the refuge and its wildlife. The issue is whether such potential conflicts can be identified and resolved in a manner that allows for continuation of the ecotourism venture but does not impede monk seal recovery. The Fish and Wildlife Service and NMFS are working cooperatively to ensure that human activities do not impede recovery at this site.

Another important habitat issue is the degrading seawall at Tern Island, French Frigate Shoals. Tern Island is the site of the U.S. Fish and Wildlife refuge station, and is one of two sites in the NWHI accessible by aircraft. The island and the runway have played a key role in efforts to study the local monk seal population, and to mitigate its severe and ongoing decline. During World War II, the U.S. Navy enlarged the island to accommodate the runway. A sheet-pile seawall was constructed to maintain the modified shape of the island. Degradation of the seawall is creating entrapment hazards for seals and other wildlife, and is threatening to erode the runway. Erosion of the sea wall has also raised concerns about the potential release of toxic wastes into the aquatic environment. The loss of the runway could lead to the closure of the Fish and Wildlife Service station at the site and would thereby reduce on-site management of the refuge. The loss of the runway and refuge station would also hinder research and management efforts to recover the monk seal population.

A fourth important habitat issue involves entanglement in marine debris. Marine debris is removed from the beaches and entangled seals during annual population assessment activities at the main reproductive sites. Efforts to remove potentially entangling marine debris from the reefs surrounding haulout sites utilized by monk seal are ongoing. In 1996, efforts commenced to assess and remove potentially entangling marine debris from reefs surrounding haulout sites utilized by monk seals. Preliminary surveys suggest a very large number of nets are fouled on nearshore reefs in the NWHI, and may pose a serious threat to seals in these areas. During 1996-1999~~8~~ debris survey and removal efforts, 35,000 kg of derelict net and other debris were removed from the coral reef~~s~~ habitat at French Frigate Shoals, ~~and~~ Pearl and Hermes Reef, Lisianski Island and Midway Atoll (Donohue et al. 2000, Donohue et al. in review).

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HARBOR PORPOISE (*Phocoena phocoena*): Central California Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the Pacific, harbor porpoise are found in coastal and inland waters from Point Conception, California to Alaska and across to Kamchatka and Japan (Gaskin 1984). Harbor porpoise appear to have more restricted movements along the western coast of the continental U.S. than along the eastern coast. Regional differences in pollutant residues in harbor porpoise indicate that they do not move extensively between California, Oregon, and Washington (Calambokidis and Barlow 1991). That study also showed some regional differences within California (although the sample size was small). This pattern stands as a sharp contrast to the eastern coast of the U.S. and Canada where harbor porpoise are believed to migrate seasonally from as far south as the Carolinas to the Gulf of Maine and Bay of Fundy (Polacheck et al. 1995). A phylogeographic analysis of genetic data from northeast Pacific harbor porpoise did not show complete concordance between DNA sequence types and geographic location (Rosel 1992). However, an analysis of molecular variance (AMOVA) of the same data with additional samples found significant genetic differences for four of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (Rosel et al. 1995). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic or migratory, and movement is sufficiently restricted that genetic differences have evolved. Recent preliminary genetic analyses of samples ranging from Monterey Bay, California to Vancouver Island, British Columbia indicate that there are at least nine genetically distinct populations, including ~~two~~ three within the present central California stock range (S. Chivers, pers. comm.).

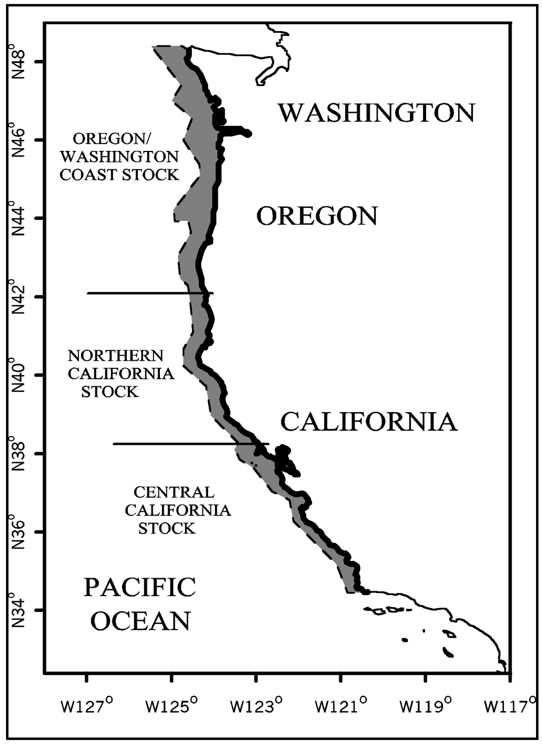

Figure 1. Stock boundaries and distributional range of harbor porpoise along the U.S. west coast. Shaded area represents harbor porpoise habitat (0-200 m) along the U.S. west coast.

In their assessment of harbor porpoise, Barlow and Hanan (1995) recommended that the animals inhabiting central California (defined to be from Point Conception to the Russian River) be treated as a separate stock. Their justifications for this were: 1) fishery mortality of harbor porpoise is limited to central California, 2) movement of individual animals appears to be restricted within California, and consequently 3) fishery mortality could cause the local depletion of harbor porpoise if central California is not managed separately. Although geographic structure exists along an almost continuous distribution of harbor porpoise from California to Alaska, stock boundaries are difficult to draw because any rigid line is (to a greater or lesser extent) arbitrary from a biological perspective. Nonetheless, failure to recognize geographic structure by defining management stocks can lead to depletion of local populations. Following the guidance of Barlow and Hanan (1995), we will consider the harbor porpoise in central California as a separate stock. However, based on recent genetic findings (Chivers, pers. comm.), it appears likely that the central California stock will be further subdivided into ~~two~~ three stocks (with ~~a~~ one division somewhere between Monterey Bay and San Francisco and another somewhere between Monterey Bay and Morro Bay) once the ongoing analyses have been finalized and peer-reviewed. Other U.S. West coast stocks are also likely to be re-evaluated at that time. For the 2000 Marine Mammal Protection Act (MMPA) Stock Assessment Reports, other Pacific coast harbor porpoise stocks include: 1) a northern California stock 2) an Oregon/Washington coast stock, 3) an Inland Washington stock, 4) a Southeast Alaska stock, 5) a Gulf of Alaska stock, and 6) a Bering Sea stock. Stock assessment reports for northern California and the Oregon and Washington stocks appear in Forney et al. (2000) and are also reprinted unrevised in this volume. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

~~Forney (1999a) estimates the abundance of central California harbor porpoise to be 5,732 (CV=0.39) based on aerial surveys in 1993-97. This estimate is not significantly different from the estimate of 4,120 (CV=0.22) presented by Barlow and Forney (1994). The more recent estimate is less precise, because it was calculated using a more recently developed correction factor for submerged animals (3.42 = 1/g(0) with g(0)=0.292, CV=0.366; Laake et al. 1997); this correction factor is slightly higher than and has a larger estimated variance than the one used by Barlow and Forney (1994; g(0)=0.324, CV=0.173). Both of these estimates only include the region between the coast and the 50-fathom (91m) isobath.~~ Previous estimates of abundance for California harbor porpoise were based on aerial surveys conducted between the coast and the 50-fm isobath during 1988-95 (Barlow and Forney 1994, Forney 1999a). These estimates did not include an unknown number of animals found in deeper waters. Barlow (1988) found that the vast majority of harbor porpoise in California were within ~~this~~ the 0-50-fm depth range; however, Green et al.(1992) found that 24% of harbor porpoise seen during aerial surveys of Oregon and Washington were between the 100m and 200m isobaths (55 to 109 fathoms). A recent analysis of harbor porpoise trends including oceanographic data suggest~~s~~ed that the proportion of California harbor porpoise in deeper waters may vary between years (Forney 1999b; see Current Population Trend below). ~~Therefore, an unknown number of animals from the central California population may have been in waters deeper than those covered by the surveys in 1993-97, and the above abundance estimate may underestimate the total population size by an unknown amount. Additional aerial surveys are planned in 1999 to cover waters deeper than 50 fathoms (91 m), and the results are expected to shed light on the magnitude of this potential bias.~~ In 1999, aerial surveys extended farther offshore (to at least the 200m depth contour) to provide a more complete abundance estimate. Although one harbor porpoise sighting was made in offshore waters under poor conditions (Beaufort sea state 3), only good conditions have traditionally been included in abundance analyses for this species (Barlow and Forney 1994, Forney 1999a), and therefore no offshore sightings contributed to the updated abundance estimate. Based on pooled 1995-99 aerial survey data, an updated estimate of abundance for the central California harbor porpoise stock is 7,579 harbor porpoise (CV=0.38; NMFS, K. Forney, unpublished data, following methods of Forney 1999a). Although this is higher than the previous estimate of 5,732 (CV=0.39, Forney 1999a), the confidence intervals overlap and the difference is not statistically significant.

Minimum Population Estimate

The minimum population estimate for harbor porpoise in central California is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from the ~~1993-97 aerial surveys (Forney 1999a) or 4,172~~ 1995-99 aerial surveys, or 5,563 animals.

Current Population Trend

Analyses of a 1986-95 time series of aerial surveys have been conducted to examine trends in harbor porpoise abundance in central California (Forney, 1995; 1999b). After controlling for the effects of sea state, cloud cover, and area on sighting rates, Forney (1995) found a negative trend in population size; however, that trend was no longer significant when sea surface temperature (a proxy measure of oceanographic conditions) was included in an updated non-linear trend analysis (Forney 1999b). The negative correlation between harbor porpoise sighting rates and sea surface temperatures indicates that apparent trends could be caused by changing oceanographic conditions and movement of animals into and out of the study area. Encounter rates for the 1997 survey, however, were very high (Forney 1999a) despite the warmer sea surface temperatures caused by strong El Niño conditions. These observations suggest that patterns of harbor porpoise movement are not directly related to sea surface temperature, but rather to the more complex distribution of potential prey species in this area. Although encounter rates during the 1999 aerial survey were again higher than in past years, the trend in relative abundance (following methods of Forney 1995) is not statistically significant (p=0.12, Figure 2). More detailed studies of encounter rate patterns in relation to satellite-derived sea surface temperature during 1993-99 are planned to shed light on potential oceanography-related movement patterns of harbor porpoise in this region.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Based on what are argued to be biological limits of the species (i.e. females give birth first at age 4 and produce one calf per year until death), the theoretical, maximum-conceivable growth rate of a closed harbor porpoise population was estimated as 9.4% per year (Barlow and Boveng 1991). This maximum theoretical rate may not be achievable for any real population. [Woodley and Read (1991) calculate a maximum growth rate of approximately 5% per year, but their argument for this being a maximum (i.e. that porpoise survival rates cannot exceed those of Himalayan thar) is not well justified.] Population growth rates have not actually been measured for any harbor porpoise population. Because a reliable estimate of the maximum net productivity rate is not available for central California harbor porpoise, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% (Wade and Angliss 1997) be employed.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size ~~(4,172)~~ (5,563) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status and a mortality rate CV $\leq$ 0.30; Wade and Angliss 1997), resulting in a PBR of ~~42~~ 56.

HUMAN-CAUSED MORTALITY

Fishery Information

The incidental capture of harbor porpoise is largely limited to the halibut set gillnet fishery in central California (coastal setnets are not allowed in northern California, and harbor porpoise do not occur in southern California). Detailed information on this fishery is provided in Appendix 1 of the U.S. Pacific Marine Mammal Stock Assessment reports for 2000 (Forney et al. 2000). A summary of estimated fishery mortality and injury for this stock of harbor porpoise is given in Table 1. ~~The mortality estimate for 1994 is based on actual 1994 observer data (Julian and Beeson 1998). At the end of 1994, however, the observer program was discontinued, and~~ The most recent mortality estimate for 1999 is based on a 1999 National Marine Fisheries Service monitoring program in Monterey Bay (Cameron and Forney 2000). Mortality estimates for 1995-98 are ~~therefore~~ based on total estimated fishing effort and prior-year entanglement rate data (Julian and Beeson 1998), because no observer program was in place during those years. Forney et al. (~~in press~~2001) evaluated uncertainties in estimating mortality for unobserved years, and presented several alternate analyses of harbor porpoise mortality for this fishery during 1995-98. Their analysis 'C', which is stratified to reflect regional differences in bycatch rates between Monterey Bay and Morro Bay and includes data from both a 1987-90 California Department of Fish and Game observer program and a 1990-94 National Marine Fisheries Service observer program, best captures the range of variability in entanglement rates and is most consistent with the patterns observed more recently in the 1999 observer program ~~(for which only preliminary results are available at this time; Table 1). Analysis 'C' is also stratified to reflect regional differences in bycatch rates between Monterey Bay and Morro Bay. Table 1 includes the 1995-98 mortality estimates from analysis 'C' in Forney et al. (in press), as was recommended by the Pacific~~

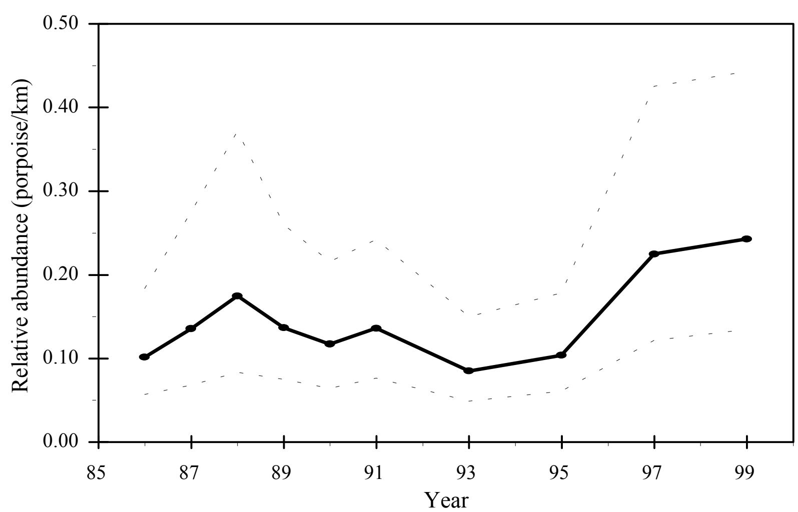

Figure 2. Relative abundance (+/- one standard error) of central California harbor porpoise, 1986-99, adjusted for sea state and cloud cover (following methods of Forney 1995).

~~Scientific Review Group at their December 1999 meeting~~. Although mortality estimates for the most recent five years (19~~94-98~~95-99) are presented in Table 1, average annual takes in the setnet fishery are calculated using only 1996-9~~8~~9 data, because fishing effort approximately doubled after 1995, and the majority of recent effort has taken place in the southern areas of Monterey Bay, where very little effort took place prior to 1996. The revised mortality data indicate that an average of ~~63~~79 harbor porpoise (CV= ~~0.19~~ 0.21) ~~have been~~ were killed ~~each year~~ annually in this fishery in central California during the period 1996-~~98~~99. ~~An observer program was initiated in the Monterey Bay area in April 1999, and the preliminary mortality estimate for January-September 1999 is 123 harbor porpoise (27 mortalities observed in 22% of total effort; NMFS, unpublished data). Thus, it appears that entanglement rates have increased substantially since the early 1990's.~~ Preliminary data for calendar year 2000 indicate that mortality in the halibut set gillnet fishery has dropped, most likely because fishing effort was lower and part of the fleet began using pingers to reduce porpoise mortality in late 1999 and early 2000.

On September 13, 2000, the California Department of Fish and Game (CDFG) issued emergency regulations which restricted fishing in the central California halibut set gillnet fishery to waters deeper than 60 fathoms, citing concerns over the continued mortality of common murres and decline of the southern sea otter population. The closure area ~~extends~~ extended from Point Reyes to Yankee Point in Monterey County and from Point Arguello to Point Sal in Santa Barbara County (the area from Yankee Point to Point Sal remained open to fishing outside of 30 fathoms). ~~The area from Yankee Point to Point Sal will remain open to halibut fishing outside of 30 fathoms. This closure is effective for 120 days and may be extended, amended, or reissued by the CDFG. The exclusion of this fishery from inshore waters less than 60 fathoms is expected to considerably reduce the mortality of harbor porpoise in Monterey Bay.~~ On April 13, 2001, CDFG proposed permanent year-round regulations to eliminate set gillnet fishing inshore of 60 fathoms from Point Reyes to Point Arguello.

Two harbor porpoise mortalities were inaccurately reported in Marine Mammal Authorization Permit (MMAP) fisher self-reports for the California drift gillnet fishery during 1996-98. Both of the mortalities occurred on an observed fishing trip and were actually short-beaked common dolphins (NMFS, Southwest Fisheries Science Center, unpublished data). This fishery has not previously been known to take harbor porpoise.

Three fishery-related harbor porpoise strandings were reported in central California in 1998, north of the known set gillnet fishing areas: two near Bodega Head and one inside San Francisco Bay (NMFS, Southwest Region, unpublished data). These mortalities were probably taken from the central California harbor porpoise stock, although it is possible that the northern two animals were taken from the northern California stock and drifted southward to the stranding location. Efforts are underway to identify possible fisheries responsible for these mortalities. Based on experience with other fisheries (e.g. the set gillnet fishery), the proportion of incidentally killed animals that strand is generally only a fraction of the total mortality, and therefore these unidentified fisheries are likely to have taken more than the three observed harbor porpoise.

STATUS OF STOCK

Harbor porpoise in California are not listed as threatened or endangered under the Endangered Species Act nor as depleted under the Marine Mammal Protection Act. Barlow and Hanan (1995) calculate the status of harbor porpoise relative to historic carrying capacity (K) using a technique called back-projection. They calculate that the central California population could have been reduced to between 30% and 97% of K by incidental fishing mortality, depending on the choice of input parameters. They conclude that there is no practical way to reduce the range of this estimate. New information does not change this conclusion, and the status of harbor porpoise relative to their Optimum Sustainable Population (OSP) levels in central California must be treated as unknown. The average annual mortality for ~~1996-98 (63~~ 1996-99 (80 harbor porpoise) is greater than the calculated PBR (~~42~~ 56) for central California harbor porpoise; therefore, the central California harbor porpoise population is "strategic" under the MMPA. The average gillnet mortality for ~~1996-98 (63~~ 1996-99 (80 porpoise per year) is greater than the calculated PBR; therefore, the fishery mortality cannot be considered insignificant and approaching zero mortality and serious injury rate. ~~Based on the success of pingers for reducing harbor porpoise mortality in east coast fisheries (Kraus et al. 1997; Trippel et al. 1999), efforts are presently underway to encourage voluntary use of pingers in the central California halibut set gillnet fishery. The observer program is scheduled to continue and will provide information on the success of any voluntary measures~~. The pending closure of the set gillnet fishery from Point Reyes to Point Arguello inside of 60 fathoms effectively will eliminate set gillnets from most harbor porpoise habitat in central California and thus it is expected that fishery mortality for this stock will be significantly reduced. Research activities will continue to monitor the population size and to investigate population trends. There are no known habitat issues that are of particular concern for this stock.

Table 1. Summary of available information on incidental mortality and injury of harbor porpoise (central CA stock) in commercial fisheries that might take this species (~~Julian and Beeson 1998;~~ Cameron and Forney 2000, Forney et al., ~~in press~~2001; NMFS/SWFSC, unpublished data). Mean annual takes are based on ~~1994-98~~ 1995-99 data unless noted otherwise. n/a indicates that data are not available.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA angel shark / halibut and other species large mesh (>3.5") set gillnet fishery	~~1994~~	~~observer data~~	~~7.7%~~	~~1~~	~~14 (0.96)~~	
	1995	1987-90	0%	-	42 (0.19)	
	1996	and	0%	-	48 (0.19)	
	1997	1990-94	0%	-	80 (0.19)	~~62 (0.19)~~
	1998	observer data	0%	-	57 (0.19)	79 (0.21)[1]
	1999	~~Prelim.~~ 1999 observer data	~~22.0%~~ 23.0%	~~27~~ 28[2]	133 (0.23)[2] ~~approx. 123 (n/a) for Jan-September~~	
Unknown fishery	~~1994-98~~ 1995-99	Strandings	-	3 (in 1998)	n/a	≥ 0.60 (n/a)
Minimum total annual takes						~~63 (0.19)~~ 80 (0.21)

[1]Only 1996-~~98~~ 99 mortality estimates are included in the average because of changes in the distribution and amount of fishing effort after 1995 (see text).

[2] This includes one unidentified cetacean that was almost certainly a harbor porpoise; without this animal the mortality estimate would be 128 (CV=0.23).

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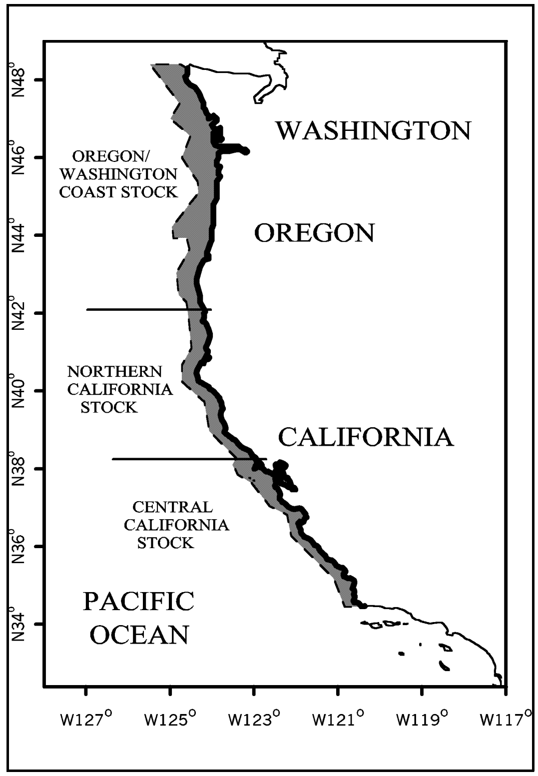

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~~Forney (1999a) estimates the abundance of northern California harbor porpoise to be 11,066 (CV=0.39) based on aerial surveys in 1993-97. This estimate is not significantly different from the estimate of 9,250 (CV=0.23) presented by Barlow and Forney (1994) based on a series of aerial surveys from 1989 to 1993. The more recent estimate is less precise, because it was calculated using a more recently developed correction factor for submerged animals (3.42 = 1/g(0) with g(0)=0.292, CV=0.366; Laake et al. 1997); this correction factor is slightly higher than and has a larger estimated variance than the one used by Barlow and Forney (1994; g(0)=0.324, CV=0.173). Both estimates only include the region between the coast and the 50-fathom (91m) isobath.~~ Previous estimates of abundance for California harbor porpoise were based on aerial surveys conducted between the coast and the 50-fm isobath during 1988-95 (Barlow and Forney 1994, Forney 1999a). These estimates did not include an unknown number of animals found in deeper waters. Barlow (1988) found that the vast majority of harbor porpoise in California were within ~~this~~ the 0-50-fm depth range; however, Green et al. (1992) found that 24% of harbor porpoise seen during aerial surveys of Oregon and Washington were between the 100m and 200m isobaths (55 to 109 fathoms). A recent analysis of harbor porpoise trends including oceanographic data suggests that the proportion of California harbor porpoise in deeper waters may vary between years (Forney 1999b; see Current Population Trend below). ~~Therefore, an unknown number of animals from the northern California population may have been in waters deeper than those covered by the surveys in 1993-97, and the above abundance estimate may underestimate the total population size by an unknown amount. Additional aerial surveys are planned for waters deeper than 50 fathoms (91 m) during 1999, and the results may shed light on the magnitude of this potential bias.~~ In 1999, aerial surveys extended farther offshore (to the 200m depth contour or 15 nmi distance, whichever is farther) to provide a more complete abundance estimate. Based on pooled 1995-99 aerial survey data including data from both inshore and offshore areas, an updated estimate of abundance for the northern California harbor porpoise stock is 15,198 harbor porpoise (CV=0.39; NMFS, K. Forney, unpublished data, following methods of Forney 1999a). Approximately 2,554 (CV=0.80) of these animals were estimated for the offshore stratum. The estimate for the inshore stratum (12,644, CV=0.38) is similar to the previous estimate of 11,066 (CV=0.39) for 1993-97 (Forney 1999b).

Minimum Population Estimate

The minimum population estimate for harbor porpoise in northern California is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from the ~~1993-97 aerial surveys (Forney 1999a) or 8,061~~ 1995-99 aerial surveys, or 11,054 animals. This estimate includes harbor porpoise within an area extending to the 200m isobath or 15 nmi, whichever is farther from shore.

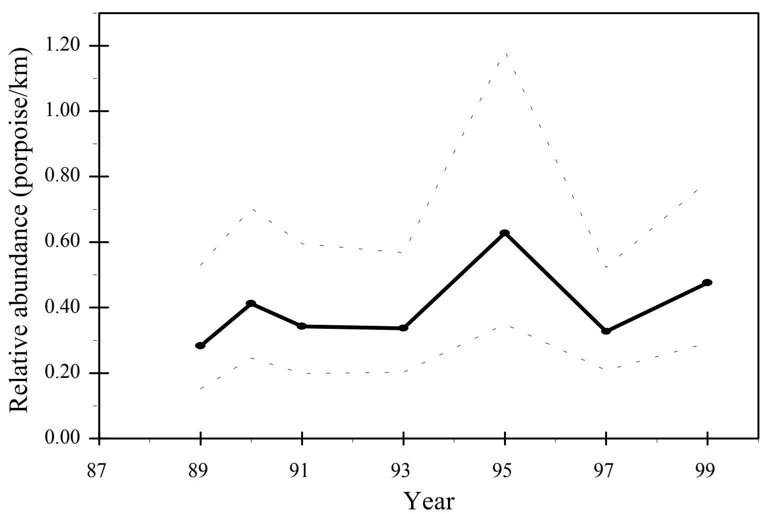

Figure 2. Relative abundance (+/- one standard error) of northern California harbor porpoise, 1989-99, adjusted for sea state and cloud cover (following methods of Forney 1995).

Current Population Trend

Forney (1999b) examines trends in relative harbor porpoise abundance in central and northern California based on aerial surveys from 1989-95. No significant trends were evident over this time period for the Northern California Stock. The 1997-99 survey results continue to show no trend in relative abundance (Figure 2).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Based on what are argued to be biological limits of the species (i.e. females give birth first at age 4 and produce one calf per year until death), the theoretical, maximum-conceivable growth rate of a closed harbor porpoise population was estimated as 9.4% per year (Barlow and Boveng 1991). This maximum theoretical rate may not be achievable for any real population. [Woodley and Read (1991) calculate a maximum growth rate of approximately 5% per year, but their argument for this being a maximum (i.e. that porpoise survival rates cannot exceed those of Himalayan thar) is not well justified.] Population growth rates have not actually been measured for any harbor porpoise population. Because a reliable estimate of the maximum net productivity rate is not available for northern California harbor porpoise, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% (Wade and Angliss 1997) be employed.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~8,061~~11,054) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 1.0 (for a species within its Optimal Sustainable Population; Wade and Angliss 1997), resulting in a PBR of ~~161~~ 221.

HUMAN-CAUSED MORTALITY

Fishery Information

The incidental capture of harbor porpoise in California is largely limited to set gillnet fisheries in central California. Coastal setnets are not allowed in northern California (to protect salmon resources there). However, one harbor porpoise mortality was documented from stranding reports for the Klamath River tribal salmon gillnet fishery in 1995 (NMFS, Southwest Region, unpublished data). Additionally, in 1998, two harbor porpoise strandings near Bodega Head were attributed to fishery-related mortality, but the responsible fishery is unknown. Although the stranding location falls within the range of the central California harbor porpoise stock and this is probably the source stock for the mortalities, it is possible that these animals were taken from the northern California stock and subsequently drifted southward to the stranding location. Efforts are underway to identify fisheries that may have been responsible.

Table 1. Summary of available information on incidental mortality and injury of harbor porpoise (northern CA stock) in fisheries that might take this species. n/a indicates that data are not available.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA Klamath River tribal salmon gillnet fishery	~~1994-98~~ 1995-99	Stranding reports	n/a	1(199~~8~~5)	≥ 1	≥ 0.2 (n/a)
Minimum total annual takes						≥ 0.2 (n/a)

STATUS OF STOCK

Harbor porpoise in California are not listed as threatened or endangered under the Endangered Species Act nor as depleted under the Marine Mammal Protection Act. There are no known habitat issues that are of particular concern for this stock. Because of the lack of recent or historical sources of human-caused mortality, the harbor porpoise stock in northern California has been concluded to be within their Optimum Sustainable Population (OSP) level (Barlow and Forney 1994). Because the known human-caused mortality or serious injury (0.2 harbor porpoise per year) is less than the PBR (~~161~~ 221), this stock is not considered a "strategic" stock under the MMPA. Because average annual fishery mortality is less than 10% of the PBR, the fishery mortality can be considered insignificant and approaching zero mortality and serious injury rate.

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Revised ~~12/15/2000~~ 4/26/2001

BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California Coastal Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bottlenose dolphins are distributed world-wide in tropical and warm-temperate waters. In many regions, including California, separate coastal and offshore populations are known (Walker 1981; Ross and Cockcroft 1990; Van Waerebeek et al. 1990). California coastal bottlenose dolphins are found within about one kilometer of shore (Figure 1; Hansen, 1990; Carretta et al. 1998; Defran and Weller 1999) primarily from Point Conception south into Mexican waters, at least as far south as Ensenada. Oceanographic events appear to influence the distribution of animals along the coasts of California and Baja California, Mexico, as indicated by a change in residency patterns along Southern California and a northward range extension into central California after the 1982-83 El Niño (Hansen and Defran 1990; Wells et al. 1990). Since the 1982-83 El Niño, which increased water temperatures off California, they have been consistently sighted in central California as far north as San Francisco. Photo-identification studies have documented north-south movements of coastal bottlenose dolphins (Hansen 1990; Defran et al. 1999), and monthly counts based on surveys between the U.S./Mexican border and Point Conception are variable (Carretta et al. 1998), indicating that animals are probably moving into and out of this area. Although coastal bottlenose dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Therefore, the management stock includes only animals found within U.S. waters. For the Marine Mammal Protection Act (MMPA) stock assessment reports, bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into three stocks: 1) California coastal stock (this report), 2) California, Oregon and Washington offshore stock, and 3) Hawaiian stock.

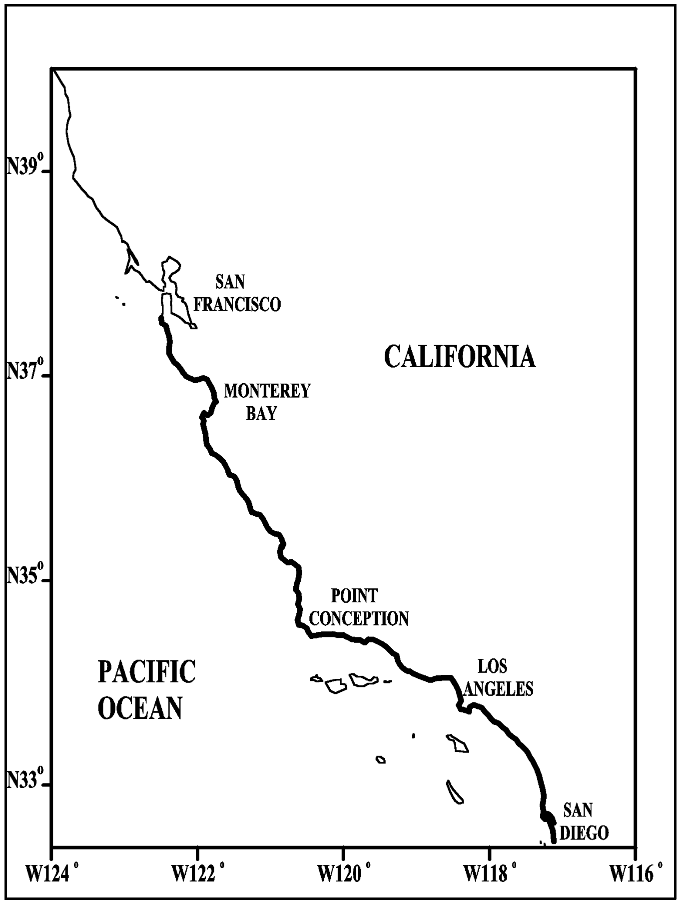

Figure 1. Approximate range (in bold) of California coastal bottlenose dolphins based on aerial surveys along the coast of California from 1990-~~99~~2000 ~~(see Appendix 2, Figure 7, for data sources and information on timing and distribution of survey effort)~~. This population of bottlenose dolphins is found within about 1 km of shore.

POPULATION SIZE

Photo-identification studies along the coasts of southern California and northern Mexico identified 404 unique individuals in this population between 1981 and 1989 based on dorsal fin characteristics, with an estimated 35% of animals lacking identifiable characters at any particular time (Defran and Weller 1999). This cannot be considered a minimum population estimate, however, because an unknown number of animals died during this period and rates of acquisition of dorsal fin characters are not known. Mark-recapture estimates based on photo-identification studies in 1985-89 range from 234 (95% CI 205-263) to 285 (95% CI 265-306) animals for the entire California-Mexico population (Defran and Weller 1999). A recent re-analysis of mark-recapture estimates from the 1980s resulted in revised abundance estimates of 289 (95% CI 230-298) for the period 1984-86 and 354 (95% CI 330-390) for 1987-89

(Dudzik 1999). The most recent photographic mark-recapture abundance estimate is 356 (95% CI 306 - 437) for the period 1996-98 (Dudzik 1999). Because coastal bottlenose dolphins spend an unknown amount of time in Mexican waters, where they are subject to mortality in Mexican fisheries, an average abundance estimate for California only is the most appropriate for U.S. management of this stock. Tandem aerial surveys were conducted in 1990-94 and 1999-2000 to estimate the abundance of coastal bottlenose dolphins throughout the southern and central California portion of their ~~U.S.~~ range and to correct for the fraction of animals missed by a single observer team. (Carretta et al. 1998, NMFS, SWFSC, unpublished data). ~~These estimates, which are corrected for the fraction of animals missed by a single observer team, range from 78 to 271 animals, with a mean abundance estimate of 140 bottlenose dolphins (CV = 0.05). These surveys did not include the central California portion of this stock's range, and therefore the published abundances underestimate the total number of animals is U.S. waters by an unknown amount. More recently, two surveys were conducted in 1994 and 1999, covering virtually the entire U.S. range of this species, from the U.S./Mexican border to just south of San Francisco, California.~~ Aerial survey correction factors have been improved using recent information on California coastal bottlenose dolphin swim speeds (Ward 1999). Using the same methods ~~and correction factors~~ as ~~in~~ Carretta et al. (1998), the weighted average abundance estimate for the 1999-2000 surveys ~~these two surveys~~ is ~~169~~ 206 (CV=~~0.11~~0.12) coastal bottlenose dolphins (NMFS, SWFSC, unpublished data). This presently is the best estimate of the average number of coastal bottlenose dolphins in U.S. waters.

Minimum Population Estimate

The log-normal 20th percentile of the above average abundance estimate for U.S. waters based on the ~~1994 and~~ 1999-2000 surveys is ~~154~~ 186 coastal bottlenose dolphins.

Current Population Trend

~~No trend in abundance of coastal bottlenose dolphins is apparent based on the available data.~~ Based on a comparison of mark-recapture abundance estimates for the periods 1987-89 ($\hat{N}$= 354) and 1996-98 ($\hat{N}$= 356), Dudzik (1999) stated that the population size had remained stable over an 11-year period.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for California coastal bottlenose dolphins.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~154~~186) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of ~~1.5~~1.9 coastal bottlenose dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Due to its exclusive use of coastal habitats, this bottlenose dolphin population is susceptible to fishery-related mortality in coastal set net fisheries. A summary of information on fishery mortality and injury for this stock of bottlenose dolphin is shown in Table 1. More detailed information on the set gillnet fishery is provided in Forney et al. (2000, Appendix 1). From 1991-94, no bottlenose dolphins were observed taken in this fishery with 10-15% observer coverage (Julian and Beeson 1998). The observer program was discontinued at the end of 1994, when coastal set gillnet fishing was banned within 3 nmi of the southern California coast. In central California, gillnets have been restricted to waters deeper than 30 fathoms (56m) since 1991 in all areas except between Point Sal and Point Arguello. Because of these closures, the potential for mortality of coastal bottlenose dolphins in the California set gillnet fishery has been greatly reduced since 1994. Fisher self-report data and stranding records for 1994-98 do not include any records of fishery interactions for this stock. Coastal gillnet fisheries exist in Mexico and probably take animals from this population, but no details are available.

Table 1. Summary of available information on the incidental mortality and serious injury of bottlenose dolphins (California Coastal Stock) in commercial fisheries that might take this species.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes
CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery	observer data	~~1991-94~~ 1995-98[1] 1999[2]	~~10.0-15.0%~~ 0.0 % 4.0 %	0	0	0
Minimum total annual takes						0

[1]The CA set gillnets were not observed from 1995-98; mortality was extrapolated from effort estimates and previous entanglement rates.
[2]Set gillnet observer coverage in 1999 was limited to Monterey Bay fishing effort only.

Other removals

Seven coastal bottlenose dolphins were collected during the late 1950s in the vicinity of San Diego (Norris and Prescott 1961). Twenty-seven additional bottlenose dolphins were captured off California between 1966 and 1982 (Walker 1975; Reeves and Leatherwood 1984), but based on the locations of capture activities, these animals probably were offshore bottlenose dolphins (Walker 1975). No additional captures of coastal bottlenose dolphins have been documented since 1982, and no live-capture permits are currently active for this species.

STATUS OF STOCK

The status of coastal bottlenose dolphins in California relative to OSP is not known, and there is no evidence of a trend in abundance. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Because no recent fishery takes have been documented, coastal bottlenose dolphins are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

Habitat Issues

Pollutant levels, especially DDT residues, found in Southern California coastal bottlenose dolphins have been found to be among the highest of any cetacean examined (O'Shea et al. 1980; Schafer et al. 1984). Although the effects of pollutants on cetaceans are not well understood, they may affect reproduction or make the animals more prone to other mortality factors (Britt and Howard 1983; O'Shea et al. 1999). This population of bottlenose dolphins may also be vulnerable to the effects of morbillivirus outbreaks, which were implicated in the 1987-88 mass mortality of bottlenose dolphins on the U.S. Atlantic coast (Lipscomb et al. 1994).

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KILLER WHALE (*Orcinus orca*): Eastern North Pacific Southern Resident Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). Along the west coast of North America, killer whales occur along the entire Alaskan coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State, where pods have been labeled as 'resident,' 'transient,' and 'offshore' (Bigg et al. 1990, Ford et al. 1994) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982, Baird and Stacey 1988, Baird et al. 1992, Hoelzel et al. 1998). Through examination of photographs of recognizable individuals and pods, movements of whales between geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (Matkin et al. 1999) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim et al. 1997). ~~Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994).~~

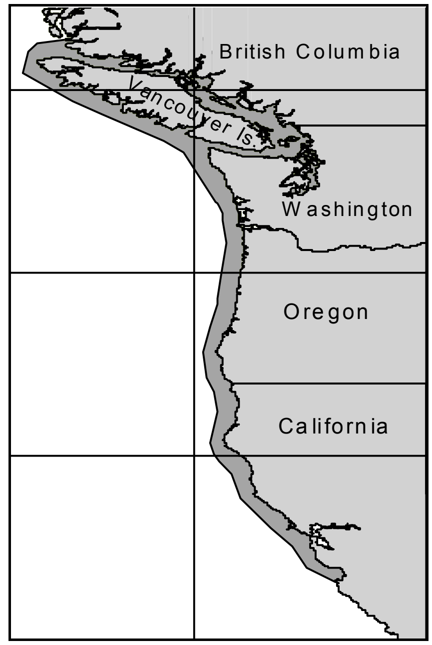

Figure 1. Approximate distribution of the Eastern North Pacific Southern Resident killer whale stock (shaded area).

Studies on mtDNA restriction patterns provide evidence that the 'resident' and 'transient' types are genetically distinct (Stevens et al. 1989, Hoelzel 1991, Hoelzel and Dover 1991, Hoelzel et al. 1998). Analysis of 73 samples collected from eastern North Pacific killer whales from California to Alaska has demonstrated significant genetic differences among 'transient' whales from California through Alaska, 'resident' whales from the inland waters of Washington, and 'resident' whales ranging from British Columbia to the Aleutian Islands and Bering Sea (Hoelzel et al. 1998). Most sightings of the Eastern North Pacific Southern Resident stock of killer whales have occurred in inland waters of Washington and southern British Columbia. However, pods belonging to this stock have also been sighted in coastal waters off Vancouver Island and Washington (Bigg et al. 1990, Ford et al. 2000), as far south as Grays Harbor (Bigg et al. 1990), and members of two pods were observed in Monterey Bay, California, in January 2000 (N. Black, pers. comm.).

Based on data regarding association patterns, acoustics, movements, genetic differences and potential fishery interactions, five killer whale stocks are recognized within the Pacific U.S. EEZ: 1) the Eastern North Pacific Northern Resident stock - occurring from British Columbia through Alaska, 2) the Eastern North Pacific Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from British Columbia through California (see Fig. 1), 3) the Eastern North Pacific Transient stock - occurring from Alaska through California, 4) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California, and 5) the Hawaiian stock. The Stock Assessment Reports for the Alaska Region contain information concerning the Eastern North Pacific Northern Resident stock.

POPULATION SIZE

The Eastern North Pacific Southern Resident stock is a trans-boundary stock including killer whales in inland Washington and southern British Columbia waters. Photo-identification of individual whales through the years has resulted in a substantial understanding of this stock's structure, behaviors, and movements. In 1993, the three pods comprising this stock totaled 96 killer whales (Ford et al. 1994). The population increased to 99 whales in 1995, then declined to the current population of 82 ~~84~~ whales in 2000 ~~1999~~ (Fig. 2; Ford et al. 2000; Center for Whale Research, unpubl. data).

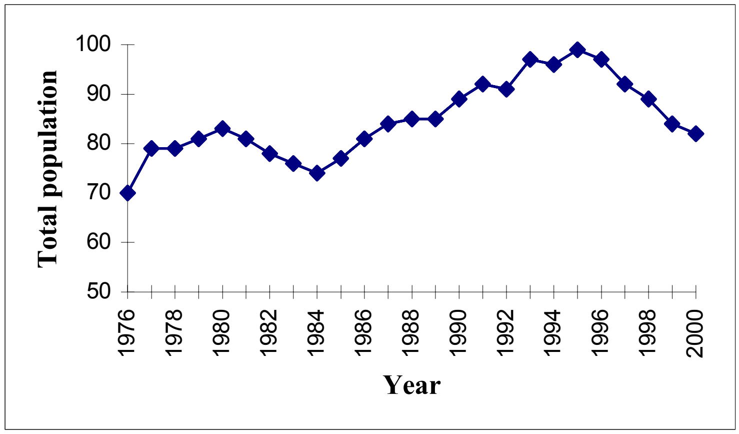

Figure 2. Population of Eastern North Pacific Southern Resident stock of killer whales 1976-~~1999~~ 2000. Each year's count includes animals first seen and first missed; a whale is considered first missed the year after it was last seen alive (Ford et al. 2000; Center for Whale Research, unpubl. data).

Minimum Population Estimate

The abundance estimate for this stock of killer whales is a direct count of individually identifiable animals. It is thought that the entire population is censused every year. This estimate therefore serves as both a best estimate of abundance and a minimum estimate of abundance. ~~Other estimates of the overall population size (i.e., N_{BEST}) and associated CV(N) are not currently available.~~ Thus, the minimum population estimate (N_{MIN}) for the Eastern North Pacific Southern Resident stock of killer whales is 82 ~~84~~ animals.

Current Population Trend

During the live-capture fishery that existed from 1967 to 1973, it is estimated that 47 killer whales, mostly immature, were taken out of this stock (Ford et al. 1994). The first complete census of this stock occurred in 1974. Between 1974 and 1993 the Southern Resident stock increased approximately 35%, from 71 to 96 individuals (Ford et al. 1994). This represents a net annual growth rate of 1.8% during those years. Since 1995, the population has declined to 82 ~~84~~ whales (Ford et al. 2000; Center for Whale Research, unpubl. data). A Southern Resident Killer Whale Workshop, sponsored by the AFSC's National Marine Mammal Laboratory (NMML), the Center for Whale Research, Six Flags Marine World Vallejo, and The Whale Museum, was held at the NMML in Seattle, WA, on 1-2 April 2000. Workshop participants discussed possible factors influencing killer whale populations including contaminant levels (Ross et al. 2000; G. Ylitalo, pers. comm.), whale-watching activities, and the availability of prey resources (NMML 2000).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this stock of killer whales. Studies of 'resident' killer whale pods in British Columbia and Washington waters resulted in estimated population growth rates of 2.92% and 2.54% over the period from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993). However, a population increases at the maximum growth rate (R_{MAX}) only when the population is at extremely low levels; thus, the estimate of 2.92% is not considered a reliable estimate of R_{MAX}. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (82 ~~84~~) times one-half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a cetacean stock of unknown status, Wade and Angliss 1997), resulting in a PBR of 0.8 whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

NMFS observers have monitored the northern Washington marine set gillnet fishery since 1988 (Gearin et al.

1994, 2000; P. Gearin, unpubl. data)~~; 1994 observer data recently became available and will be included in a future stock assessment report~~. Observer coverage ranged from approximately ~~40~~ 33 to 98% in the entire fishery (coastal + inland waters) between ~~1993~~ 1994 and 1998. There was no observer coverage in this fishery in 1999, however, the total fishing effort was only 4 net days (in inland waters) and no marine mammals were reported taken. Data from ~~1993~~ 1994 to 1999 ~~1998~~ are included in Table 1, although the mean estimated annual mortality is calculated using only the most recent 5 years for which data are available. No killer whale mortalities have been recorded in this fishery since the inception of the observer program.

In 1993, as a pilot for future observer programs, NMFS in conjunction with the Washington Department of Fish and Wildlife (WDFW) monitored all non-treaty components of the Washington Puget Sound Region salmon gillnet fishery (Pierce et al. 1994). Observer coverage was 1.3% overall, ranging from 0.9% to 7.3% for the various components of the fishery. Encounters (whales within 10 m of a net) with killer whales were reported, but not quantified, though no entanglements occurred.

In 1994, NMFS and WDFW conducted an observer program during the Puget Sound non-treaty chum salmon gillnet fishery (areas 10/11 and 12/12B). A total of 230 sets were observed during 54 boat trips, representing approximately 11% observer coverage of the 500 fishing boat trips comprising the total effort in this fishery, as estimated from fish ticket landings (Erstad et al. 1996). No interactions with killer whales were observed during this fishery. The Puget Sound treaty chum salmon gillnet fishery in Hood Canal (areas 12, 12B, and 12C) and Puget Sound treaty sockeye/chum gillnet fishery in the Strait of Juan de Fuca (areas 4B, 5, and 6C) were also monitored in 1994 at 2.2% (based on % of total catch observed) and approximately 7.5% (based on % of observed trips to total landings) observer coverage, respectively (NWIFC 1995). No interactions resulting in killer whale mortalities were reported in either treaty salmon gillnet fishery.

Also in 1994, NMFS, WDFW, and the Tribes conducted an observer program to examine seabird and marine mammal interactions with the Puget Sound treaty and non-treaty sockeye salmon gillnet fishery (areas 7 and 7A). During this fishery, observers monitored 2,205 sets, representing approximately 7% of the estimated number of sets in the fishery (Pierce et al. 1996). Killer whales were observed within 10 m of the gear during 10 observed sets (32 animals in all), though none were observed to have been entangled.

An additional source of information on the number of killer whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1994 and 1999 ~~1998~~, there were no fisher self-reports of killer whale mortalities from any fisheries operating within the range of this stock. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 4 of Hill and DeMaster 1998).

Table 1. Summary of incidental mortality of killer whales (Eastern North Pacific Southern Resident stock) due to commercial and tribal fisheries and calculation of the mean annual mortality rate; n/a indicates that data are not available. Mean annual takes are based on ~~1994-98~~ 1995-1999 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Northern WA marine set gillnet (tribal fishery: coastal + inland waters)	~~93~~ ~~94~~ 95 96 97 98 99	obs data	~~61%~~ ~~n/a~~ 87% 59% 98% 40% 0%	~~0~~ ~~n/a~~ 0 0 0 0 n/a	~~0~~ ~~n/a~~ 0 0 0 0 n/a	0[1]
WA Puget Sound Region salmon set/drift gillnet (observer programs listed below covered segments of this fishery):	-	-	-	-	-	-

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Puget Sound non-treaty salmon gillnet (all areas and species)	93	obs data	1.3%	0	0	0
Puget Sound non-treaty chum salmon gillnet (areas 10/11 and 12/12B)	94	obs data	11%	0	0	0
Puget Sound treaty chum salmon gillnet (areas 12, 12B, and 12C)	94	obs data	2.2%	0	0	0
Puget Sound treaty chum and sockeye salmon gillnet (areas 4B, 5, and 6C)	94	obs data	7.5%	0	0	0
Puget Sound treaty and non-treaty sockeye salmon gillnet (areas 7 and 7A)	94	obs data	7%	0	0	0
Minimum total annual takes						0

[1]~~1993 and 1995~~1994-98 mortality estimates are included in the average.

Due to a lack of observer programs, there are few data concerning the mortality of marine mammals incidental to Canadian commercial fisheries. Since 1990, there have been no reported fishery-related strandings of killer whales in Canadian waters. However, in 1994 one killer whale was reported to have contacted a salmon gillnet but did not entangle (Guenther et al. 1995). Data regarding the level of killer whale mortality related to commercial fisheries in Canadian waters are not available, though the mortality level is thought to be minimal.

During this decade there have been no reported takes from this stock incidental to commercial fishing operations (D. Ellifrit, pers. comm.), no reports of interactions between killer whales and longline operations (as occurs in Alaskan waters; see Yano and Dahlheim 1995), no reports of stranded animals with net marks, and no photographs of individual whales carrying fishing gear. The total fishery mortality and serious injury for this stock is zero.

STATUS OF STOCK

Killer whales are not listed as "depleted" under the MMPA or listed as "threatened " or "endangered" under the Endangered Species Act. Based on currently available data, the total fishery mortality and serious injury for this stock (0) is not known to exceed 10% of the calculated PBR (0.08) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury of zero animals per year is not known to exceed the PBR (0.8). Therefore, the Eastern North Pacific Southern Resident stock of killer whales is not classified as a strategic stock. The stock size has decreased in recent years, although at this time it is not possible to assess the status of this stock relative to its Optimum Sustainable Population (OSP) level.

In April 1999, Canada's Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed resident killer whales in British Columbia as "threatened," i.e., likely to become "endangered" if limiting factors are not reversed (Baird 1999). In June 2000, the Washington Department of Fish and Wildlife designated killer whales in Washington State as a "state candidate species" (a species that the Department will review for possible listing as "state endangered, threatened, or sensitive").

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SPERM WHALE (*Physeter macrocephalus*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sperm whales are widely distributed across the entire North Pacific and into the southern Bering Sea in summer but the majority are thought to be south of 40ºN in winter (Rice 1974; Gosho et al. 1984; Miyashita et al. 1995). For management, the International Whaling Commission (IWC) had divided the North Pacific into two management regions (Donovan 1991) defined by a zig-zag line which starts at 150ºW at the equator, is 160ºW between 40-50ºN, and ends up at 180ºW north of 50ºN; however, the IWC has not reviewed this stock boundary in many years (Donovan 1991). Sperm whales are found year-round in California waters (Dohl et al. 1983; Barlow 1995; Forney et al. 1995), but they reach peak abundance from April through mid-June and from the end of August through mid-November (Rice 1974). They were seen in every season except winter (Dec.-Feb.) in Washington and Oregon (Green et al. 1992). Of 176 sperm whales that were marked with Discovery tags off southern California in winter 1962-70, only three were recovered by whalers: one off northern California in June, one off Washington in June, and another far off British Columbia in April (Rice 1974). Recent summer/fall surveys in the eastern tropical Pacific (Wade and Gerrodette 1993) show that although sperm whales are widely distributed in the tropics, their relative abundance tapers off markedly westward towards the middle of the tropical Pacific (near the IWC stock boundary at 150ºW) and tapers off northward towards the tip of Baja California. The structure of sperm whale populations in the eastern tropical Pacific is not known, but the only photographic matches of known individuals from this area have been between the Galapagos Islands and coastal waters of South America (Dufault and Whitehead 1995), suggesting that the eastern tropical animals constitute a distinct stock. A recent survey designed specifically to investigate stock structure and abundance of sperm whales in the northeastern temperate Pacific revealed no apparent hiatus in distribution between the U.S. EEZ off California and areas farther west, out to Hawaii (Barlow and Taylor 1998). Recent analyses of genetic relationships of animals in the eastern Pacific found that mtDNA and microsatellite DNA of animals sampled in the California Current is significantly different from animals sampled further offshore and that genetic differences appeared larger in an east-west direction than in a north-south direction (Mesnick et al.~~, in press~~ 1999).

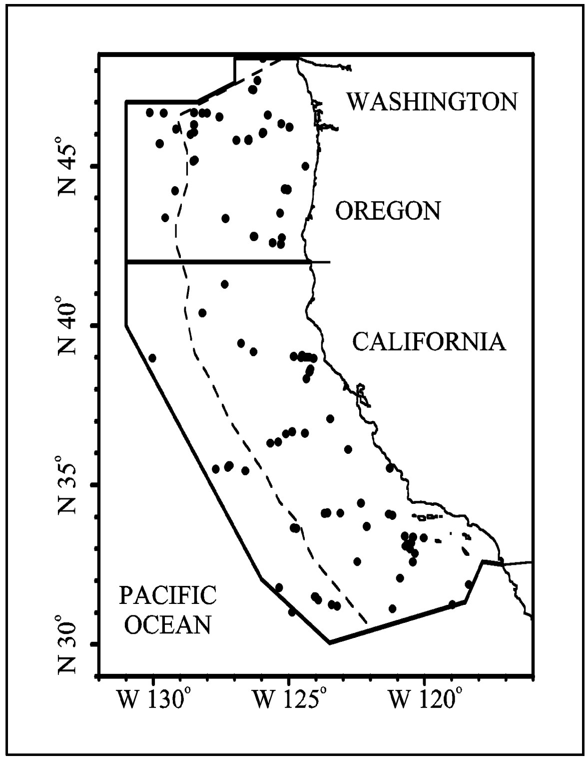

Figure 1. Sperm whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1989-96. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined. Greater effort was conducted off California (south of 42°N) and in the inshore half of the U.S. EEZ. See Appendix 2 of Barlow et al. (1997) and Barlow (1997) for data sources and information on timing and location of survey effort.

For the Marine Mammal Protection Act (MMPA) stock assessment reports, sperm whales within the Pacific U.S. EEZ are divided into three discrete, non-contiguous areas: 1) California, Oregon and Washington waters (this report), 2) waters around Hawaii, and 3) Alaska waters.

POPULATION SIZE

~~Barlow (1997)~~ Barlow and Taylor (in press) estimates ~~1,191 (CV=0.22)~~ 1,407 (CV=0.39) sperm whales along the coasts of California, Oregon, and Washington during summer/fall based on ship line transect surveys in ~~1991,~~ 1993~~,~~ and 1996 ~~(lognormal 95% C.I.= 778-1,824)~~. This most recent estimate has been corrected for the systematic underestimation of sperm whale group size when groups are observed for only a short period of time. Forney et al. (1995) estimate 892 (CV=0.99) sperm whales off California during winter/spring based on aerial line-transect surveys in 1991-92 ~~(95% C.I.=176-4,506)~~, but this estimate does not correct for diving whales that were missed and is now more than 8 years out of date. ~~Because of the long dive time of sperm whales (Leatherwood et al. 1982), it is reasonable to assume that a corrected estimate would be three to eight times the estimates from aerial surveys.~~ Green et al. (1992) report that sperm whales were the third most abundant large whale (after gray and humpback whales) in aerial surveys off Oregon and Washington, but they did not estimate population size for that area. A large 1982 abundance estimate for the entire eastern North Pacific (Gosho et al. 1984) was based on a CPUE method which is no longer accepted as valid by the International Whaling Commission. Recently, a combined visual and acoustic line-transect survey conducted in the eastern temperate North Pacific in spring 1997 resulted in estimates of 24,000 (CV=0.46) sperm whales based on visual sightings, and 39,200 (CV=0.60) based acoustic detections and visual group size estimates (Barlow and Taylor 1998). However, it is not known whether any or all of these animals routinely enter the U.S. EEZ. In the eastern tropical Pacific, the abundance of sperm whales has been estimated as 22,700 (95% C.I.=14,800-34,600; Wade and Gerrodette 1993), but this area does not include areas where sperm whales are taken by drift gillnet fisheries in the U.S. EEZ and there is no evidence of sperm whale movements from the eastern tropical Pacific to the U.S. EEZ. Barlow and Taylor (in press) also estimate 1,640 (CV=0.33) sperm whales off the west coast of Baja California, but again there is no evidence for interchange between these animals and those off California, Oregon and Washington.

Clearly, large populations of sperm whales exist in waters that are within several thousand miles west and south of the California, Oregon, and Washington region that is covered by this report; however, there is no evidence of sperm whale movements into this region from either the west or south and genetic data suggest that mixing to the west is extremely unlikely. There **is** limited evidence of sperm whale movement from California to northern areas off British Columbia, but there are no abundance estimates for this area. The most precise estimate of sperm whale abundance for this stock is therefore from the ship survey estimate of ~~Barlow (1997)~~ Barlow and Taylor (in press). ~~; however, this is probably an underestimate of true abundance because recent studies suggest sperm whale group sizes may have been underestimated on past line-transect surveys (Barlow and Taylor 1998; B. Taylor, unpubl. data).~~

Minimum Population Estimate

The minimum population estimate for sperm whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from the summer/fall ship surveys off California, Oregon and Washington ~~(Barlow 1997~~ Barlow and Taylor, in press) or approximately ~~992~~ 1,026. More sophisticated methods of estimating minimum population size would be available if a correction factor (and associated variance) were available to correct the aerial survey estimates for missed animals.

Current Population Trend

Sperm whale abundance appears to have been rather variable off California between 1979/80 and 1996 (Barlow 1994; Barlow 1997) but does not show any obvious trends. Although the population in the eastern North Pacific is expected to have grown since large-scale pelagic whaling stopped in 1980, the possible effects of large unreported catches are unknown (Yablokov 1994) and the ongoing incidental ship strikes and gillnet mortality make this uncertain.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no published estimates of the growth rate for any sperm whale population (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the California portion of this stock is calculated as the minimum population size (~~992~~ 1,026) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (the default value for an endangered species), resulting in a PBR of ~~2.0~~ 2.1.

HUMAN-CAUSED MORTALITY

Historic Whaling

Between 1800 and 1909, about 60,842 sperm whales were estimated taken in the North Pacific (Best 1976). The reported take of North Pacific sperm whales by commercial whalers between 1947 and 1987 totaled 258,000 (C. Allison, pers. comm.). Ohsumi (1980) lists an additional 28,198 sperm whales taken mainly in coastal whaling operations from 1910 to 1946. Based on the massive under-reporting of Soviet catches, Brownell et al. (1998) estimate that about 89,000 whales were additionally taken by the Soviet pelagic whaling fleet between 1949 and 1979. The Japanese coastal operations apparently also under-reported catches by an unknown amount (Kasuya 1998). Thus a total of at least 436,000 sperm whales were taken between 1800 and the end of commercial whaling for this species in 1987. Of this grand total, an estimated 33,842 were taken by Soviet and Japanese pelagic whaling operations in the eastern North Pacific from the longitude of Hawaii to the U.S. West coast, between 1961 and 1976 (Allen 1980, IWC statistical Areas II and III), and 965 were reported taken in land-based U.S. West coast whaling operations between 1947 and 1971 (Ohsumi 1980). In addition, 13 sperm whales were taken by shore whaling stations in California between 1919 and 1926 (Clapham et al. 1997). There has been a prohibition on taking sperm whales in the North Pacific since 1988, but large-scale pelagic whaling stopped earlier, in 1980.

Fishery Information

The offshore drift gillnet fishery is the only fishery that is likely to take sperm whales from this stock. Detailed information on this fishery is provided in Forney et al. 2000 (Appendix 1). A 199~~4~~5-9~~8~~9 summary of known fishery mortality and injury for this stock of sperm whales is given in Table 1. After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 1999). However, two sperm whales have been observed taken in nets with pingers (1996 and 1998). Because sperm whale entanglement is rare and because those nets which took sperm whales did not use the full mandated complement of pingers, it is difficult to evaluate whether pingers have any effect on sperm whale entanglement in drift gillnets. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes for this fishery (Table 1) are based only on 1997-9~~8~~9data. This results in an average estimate of ~~2.5~~ 1.7 (CV = 0.89) sperm whale mortalities per year.

Table 1. Summary of available information on the incidental mortality and injury of sperm whales (CA/OR/WA stock) for commercial fisheries that might take this species (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999). Injury includes any entanglement that does not result in immediate death and may include serious injury resulting in death. The injured whale observed in 1996 was not expected to survive . n/a indicates that data are not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality (and injury in parentheses)	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1994~~	observer data	~~17.9%~~	~~0~~	Mortality	Mortality
	1995		15.6%	0	~~0,~~0,0,0,5,0	~~2.5 (0.89)[1]~~
	1996		12.4%	0 (1)	(0.89)	1.7 (0.89)[1]
	1997		23.0%	0	Injury	Injury
	1998		20.0%	1	~~0,~~0,1,0,0,0	0.0 (n/a)
	1999		20.0%	0		
Total annual takes						~~2.5~~ 1.7 (0.89)

[1] Only ~~1997-98~~ 1997-99 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California and may take animals from the same population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2,700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson,1998), but species-specific information is not available for the Mexican fisheries. There are currently efforts underway to convert the Mexican swordfish driftnet fishery to a longline fishery (D. Holts, pers. comm.).

Ship Strikes

No sperm whale mortalities have been attributed to ship strikes during the period 1994-98 (J. Cordaro, Southwest Region, NMFS, pers. comm.).

STATUS OF STOCK

The only estimate of the status of North Pacific sperm whales in relation to carrying capacity (Gosho et al. 1984) is based on a CPUE method which is no longer accepted as valid. Sperm whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the California to Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The annual rate of kill and serious injury (~~2.5~~ 1.7 per year) is ~~greater~~ less than the calculated PBR for this stock (~~2.0~~ 2.1). ~~which would also result in the classification of this stock as~~ not ~~“strategic”.~~ Total fishery takes ~~are~~ may not be approaching zero mortality and serious injury rate. The increasing levels of anthropogenic noise in the world’s oceans has been suggested to be a habitat concern for whales, particularly for deep-diving whales like sperm whales that feed in the oceans “sound channel”.

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HUMPBACK WHALE (*Megaptera novaeangliae*): ~~California/Oregon/Washington - Mexico~~ Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Although the International Whaling Commission (IWC) only considered one stock (Donovan 1991), there is now good evidence for multiple populations of humpback whales in the North Pacific (Johnson and Wolman 1984; Baker et al. 1990). Aerial, vessel, and photo-identification surveys, and genetic analyses indicate that within the U.S. EEZ, there are at least three relatively separate populations that migrate between their respective summer/fall feeding areas and winter/spring calving and mating areas (Calambokidis et al. 1997, Baker et al. 1998): 1) winter/spring populations in coastal Central America and Mexico which migrate to the coast of California to southern British Columbia in summer/fall (Steiger et al. 1991, Calambokidis et al. 1993) - referred to as the ~~California/Oregon/Washington - Mexico~~ eastern North Pacific stock (Figure 1); 2) winter/spring populations of the Hawaiian Islands which migrate to northern British Columbia/Southeast Alaska and Prince William Sound west to Kodiak (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 1997) - referred to as the central North Pacific stock; and 3) winter/spring populations of Japan which, based on Discovery Tag information, probably migrate to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands) in summer/fall (Berzin and Rovnin 1966, Nishiwaki 1966, Darling 1991) - referred to as the western North Pacific stock. Winter/spring populations of humpback whales also occur in Mexico's offshore islands; the migratory destination of these whales is not well known (Calambokidis et al. 1993, Calambokidis et al. 1997), but Norris et al. (1999) speculate that they may travel to the Bering Sea or Aleutian Islands. Significant levels of genetic differences were found between the California and Alaska feeding groups based on analyses of mitochondrial DNA (Baker et al. 1990) and nuclear DNA (Baker et al. 1993). The genetic exchange rate between California and Alaska is estimated to be less than 1 female per generation (Baker 1992). Two breeding areas (Hawaii and coastal Mexico) showed fewer genetic differences than did the two feeding areas (Baker 1992). This is substantiated by the observed movement of individually-identified whales between Hawaii and Mexico (Baker et al. 1990). There have been no individual matches between 597 humpbacks photographed in California and 617 humpbacks photographed in Alaska (Calambokidis et al. 1996). Only two of the 81 whales photographed in British Columbia have matched with a California catalog (Calambokidis et al. 1996), indicating that the U.S./Canada border is an approximate geographic boundary between feeding populations.

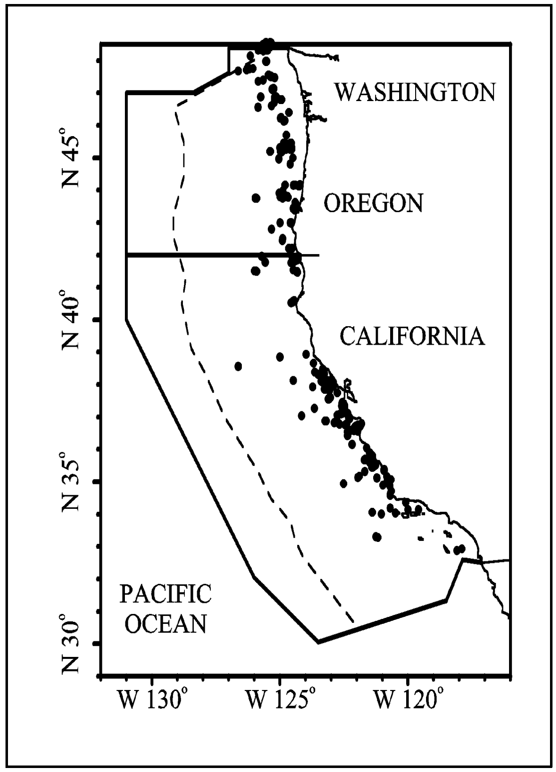

Figure 1. Humpback whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1989-96. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined. Greater effort was conducted off California (south of 42°N) and in the inshore half of the U.S. EEZ. See Appendix 2 of Barlow et al. (1997) and Barlow (1997) for data sources and information on timing and location of survey effort.

Until further information becomes available, three management units of humpback whales (as described above) are recognized within the U.S. EEZ of the North Pacific: the ~~California/Oregon/Washington - Mexico~~ eastern North Pacific stock (this report), the central North Pacific stock, and the western North Pacific stock. The central and western North Pacific stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Based on whaling statistics, the pre-1905 population of humpback whales in the North Pacific was estimated to be 15,000 (Rice 1978), but this population was reduced by whaling to approximately 1,200 by 1966 (Johnson and Wolman 1984). The North Pacific total now almost certainly exceeds 6,000 humpback whales (Calambokidis et al. 1997). Dohl et al. (1983) first estimated the central California feeding population to be 338 (CV=0.29) based on aerial surveys in August through November of 1980-83; however, this estimate does not include a correction for submerged animals. More recently, the size of the "California" feeding stock of humpback whales has been estimated by three independent methods. 1) Calambokidis et al. (~~1999~~2000) estimated the number of humpback whales in California-Washington to be ~~905 (CV=0.06)~~ 1,024 (CV=0.10) based on mark-recapture estimates comparing their ~~1997~~ 1998 and ~~1998~~ 1999 photo-identification catalogs. 2) Barlow and Taylor (~~1997~~ in press) estimates ~~1,152 (CV=0.15)~~ 1,177 (CV=0.28) humpbacks in California, Oregon and Washington waters based on ship line-transect surveys in summer/autumn of ~~1991,~~ 1993 and 1996. 3) Forney et al. (1995) estimate 319 (CV=0.41) humpback whales in California coastal waters based on aerial line-transect surveys in winter/spring of 1991 and 1992 (not corrected for diving whales). ~~In addition,~~ Green et al. (1992) report that humpback whales were the second most abundant large whale (after the gray whale) in aerial surveys off Oregon and Washington, but they did not estimate population size. Based on photographic mark-recapture techniques, Urban et al. (1999) estimate that the 1987-92 population of humpback whales was 1,162 in coastal Mexico and 642 near the Revillagigedos Islands. ~~These estimates for the west-coast stock are not significantly different from each other. The shipboard estimates are likely to be the most unbiased, and the aerial surveys are likely to be the most negatively biased because submerged animals are missed. Mark-recapture estimates may also be negatively biased due to heterogeneity in sighting probabilities (Hammond 1986). However, given that the above mark-recapture estimate is based on a large fraction of the entire population (1997-98 catalog contained 544 known individuals), this bias is likely to be minimal. Also, in previous mark-recapture analyses on the same population, when methods were used which account for heterogeneity, estimates were comparable or smaller (Calambokidis et al. 1993). The most precise and least biased estimate is likely to be the mark-recapture~~

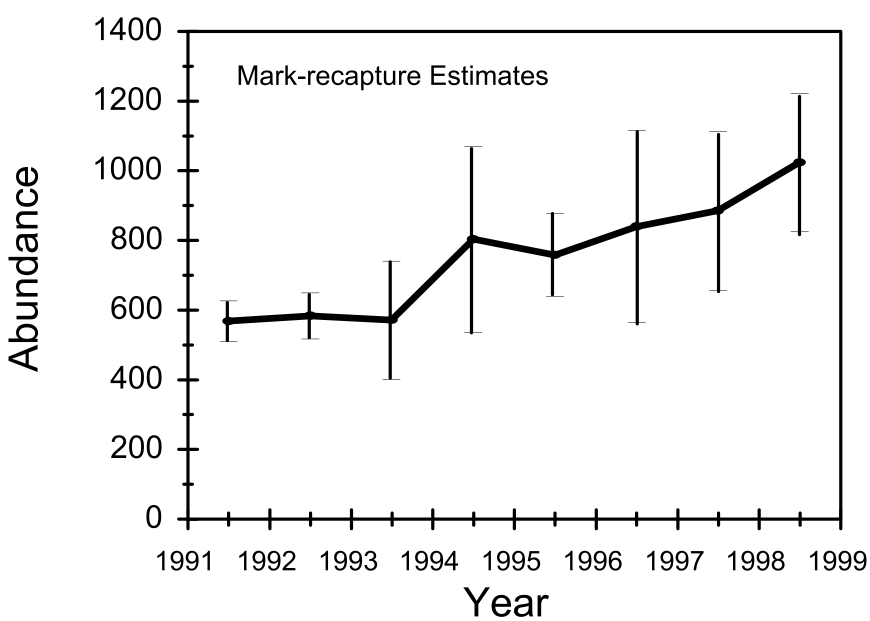

Figure 1. Mark-recapture estimates of the abundance of humpback whales feeding off California, Oregon, and Washington based on photo-identification studies (Calambokidis et al. 2000).

~~estimate of 905 (CV=0.06) humpback whales for this population.~~ The best estimate of abundance for the eastern North Pacific stock of humpback whales is the photographic mark-recapture estimate of 1,024 (CV=0.10) whales along the U.S. west coast (Calambokidis et al. 2000). In general, mark-recapture estimates are negatively biased due to heterogeneity in sighting probabilities (Hammond 1986); however, this bias is likely to be minimal because the above mark-recapture estimate is based on data from over half of the entire population (the 1998-99 catalog contained 594 known individuals). The photographic mark-recapture estimates from Mexico (Urban et al. 1999) include whales from several feeding destinations and probably two different stocks. The aerial line-transect estimates (Forney et al. 1995) are more than 8 years old and do not include corrections for diving whales that would be missed. The ship line transect estimate (Barlow, in press) is less precise than the mark-recapture estimates and is negatively biased because it does not include some humpback whales which could not be identified in the field and which were recorded as "unidentified large whale".

Minimum Population Estimate

The minimum population estimate for humpback whales in the California/Mexico stock is taken as the lower 20th percentile of the log-normal distribution of ~~1997-98~~ 1998-99 abundance estimated from mark-recapture methods (Calambokidis et al. 1999) or approximately ~~861~~ 944.

Current Population Trend

Ship surveys provide some indication that humpback whales increased in abundance in California coastal waters between 1979/80 and 1991 (Barlow 1994) and between 1991 and 1996 (Barlow 1997). Mark-recapture population estimates increased steadily from 1988/90 to 1997-98 at about 8% per year (Calambokidis et al. 1999) and the estimate for 1998-99 is again higher than previous estimates (Calambokidis et al. 2000). Population estimates for the entire North Pacific have also increased substantially from 1,200 in 1966 to 6,000-8,000 circa 1992. Although these estimates are based on different methods and the earlier estimate is extremely uncertain, the growth rate implied by these estimates (6-7%) is consistent with the recently observed growth rate of the ~~California/Oregon/Washington~~ eastern North Pacific stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The proportion of calves in the California/Mexico stock from 1986 to 1994 appeared much lower than previously measured for humpback whales in other areas (Calambokidis and Steiger 1994), but in 1995-97 a greater proportion of calves were identified, and the 1997 reproductive rates for this population are closer to those reported for humpback whale populations in other regions (Calambokidis et al. 1998). Despite the apparently low proportion of calves, two independent lines of evidence indicate that this stock appears to be growing (Barlow 1994; Calambokidis et al. ~~1999~~ 2000) with a best estimate of 8% growth per year (Calambokidis et al. 1999).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~861~~ 944) <u>times</u> one half the estimated population growth rate for this stock of humpback whales (½ of 8%) <u>times</u> a recovery factor of 0.1 (for an endangered species), resulting in a PBR of ~~3.4~~ 3.8. Because this stock spends approximately half its time outside the U.S. EEZ, the PBR allocation for U.S. waters is ~~1.7~~ 1.9 whales per year.

HUMAN-CAUSED MORTALITY

Historic Whaling

The reported take of North Pacific humpback whales by commercial whalers totaled approximately 7,700 between 1947 and 1987 (C. Allison, pers. comm.). In addition, approximately 7,300 were taken along the west coast of North America from 1919 to 1929 (Tonnessen and Johnsen 1982). Total 1910-1965 catches from the California-Washington stock includes at least the 2,000 taken in Oregon and Washington, the 3,400 taken in California, and the 2,800 taken in Baja California (Rice 1978). Shore-based whaling apparently depleted the humpback whale stock off California twice: once prior to 1925 (Clapham et al. 1997) and again between 1956 and 1965 (Rice 1974). There has been a prohibition on taking humpback whales since 1966.

Fishery Information

A ~~1994-98~~ 1995-99 summary of known fishery mortality and injury for this stock of humpback whales is given in Table 1. Detailed information on these fisheries is provided in Forney et al. (2000, Appendix 1). After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 1999). Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes for this fishery (Table 1) are based only on ~~1997-98~~ 1997-99 data. This results in an average estimate of zero humpback whales taken annually. Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net. The deaths of two humpback whales that stranded in the Southern California Bight have been attributed to entanglement in fishing gear (Heyning and Lewis 1990), and a humpback whale was observed off Ventura, CA in 1993 with a 20 ft section of netting wrapped around and trailing behind. During the period 1995-99, a humpback cow-calf pair was seen entangled in a net off Big Sur, California (1999), but the fate of these animals is not known ~~, but no other gillnet-caused strandings or entanglements were reported for the period 1994-98~~ (J. Cordero, NMFS SW Region, pers. comm.). Other unobserved fisheries may also result in injuries or deaths of humpback whales. In 1997, one humpback whale was snagged by a central California salmon troller, and the animal swam away with the hook and many feet of trailing monofilament (NMFS, Southwest Region, unpublished data); this type of injury is not likely to be serious.

Table 1. Summary of available information on the incidental mortality and injury of humpback whales (~~CA/OR/WA - Mexico~~ eastern North Pacific stock) for commercial fisheries that might take this species (Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999, 2000). Injury includes any entanglement that does not result in immediate death and may include serious injury resulting in death. n/a indicates that data are not available. Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality (and Injury)	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1994~~ 1995 1996 1997 1998 1999	observer data	~~17.9%~~ 15.6% 12.4% 23.0% 20.0% 20.0%	~~0 (1)~~ 0 0 0 0 0	Mortality ~~0,~~0,0,0,0,0 Injury ~~6,~~0,0,0,0,0 ~~(0.91)~~	Mortality 0 Injury 0[1]
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	1990-94	observer data	10-15%	0,0,0,0,0	0,0,0,0,0	n/a
CA salmon troll fishery	1997	incidental report	0%	(1)	n/a	Injury >0.2 (n/a)
Total annual takes						>0.2

[1] Only ~~1997-98~~ 1997-99 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California and may take animals from the same population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2,700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fisheries. There are currently efforts underway to convert the Mexican swordfish driftnet fishery to a longline fishery (D. Holts, pers. comm.).

Ship Strikes

Ship strikes were implicated in the deaths of at least two humpback whales in 1993 and one humpback whale in 1995, and one unidentified whale, which may have been a humpback whale, was struck and injured by a small boat in 1997 (J. Cordaro, pers. comm.). Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not have obvious signs of trauma. Several humpback whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (J. Calambokidis, pers. comm.). The average number of humpback whale deaths by ship strikes for ~~1994-98~~ 1995-99 is at least 0.2 per year.

STATUS OF STOCK

Humpback whales in the North Pacific were estimated to have been reduced to 13% of carrying capacity (K) by commercial whaling (Braham 1991). Clearly the North Pacific population was severely depleted. The initial abundance has never been estimated separately for the ~~"California"~~ eastern North Pacific stock, but this stock was also depleted (probably twice) by whaling (Rice 1974; Clapham et al. 1997). Humpback whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the California/Mexico stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The estimated annual mortality and injury due to entanglement (0.2/yr) plus ship strikes (0.2/yr) in California is less than the PBR allocation of ~~1.7~~ 1.9 for U.S. waters. In a review of the severity of injury to the humpback whale entangled in ~~1994~~ 1997, the Pacific Scientific Review Group determined that it this animal was not seriously injured. Based on strandings and gillnet observations, annual humpback whale mortality and serious injury in California's drift gillnet fishery is probably greater than 10% of the PBR; therefore, total fishery mortality ~~is~~ may not be approaching zero mortality and serious injury rate. The ~~California~~ eastern North Pacific stock appears to be increasing in abundance. The increasing levels of anthropogenic noise in the world's oceans, such as those produced by ATOC (Acoustic Thermometry of Ocean Climate) or LFA (Low Frequency Active) Sonar, have been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound.

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FIN WHALE (*Balaenoptera physalus*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) recognized two stocks of fin whales in the North Pacific: the East China Sea and the rest of the North Pacific (Donovan 1991). Mizroch et al. (1984) cites evidence for additional fin whale subpopulations in the North Pacific. From whaling records, fin whales that were marked in winter 1962-70 off southern California were later taken in commercial whaling operations between central California and the Gulf of Alaska in summer (Mizroch et al. 1984). More recent observations show aggregations of fin whales year-round in southern/central California (Dohl et al. 1983; Barlow 1997; Forney et al. 1995), year-round in the Gulf of California (Tershy et al. 1993), in summer in Oregon (Green et al. 1992; McDonald 1994), and in summer/autumn in the Shelikof Strait/Gulf of Alaska (Brueggeman et al. 1990). Acoustic signals from fin whale are detected year-round off northern California, Oregon and Washington, with a concentration of vocal activity between September and February (Moore et al. 1998). Fin whales appear very scarce in the eastern tropical Pacific in summer (Wade and Gerrodette 1993) and winter (Lee 1993).

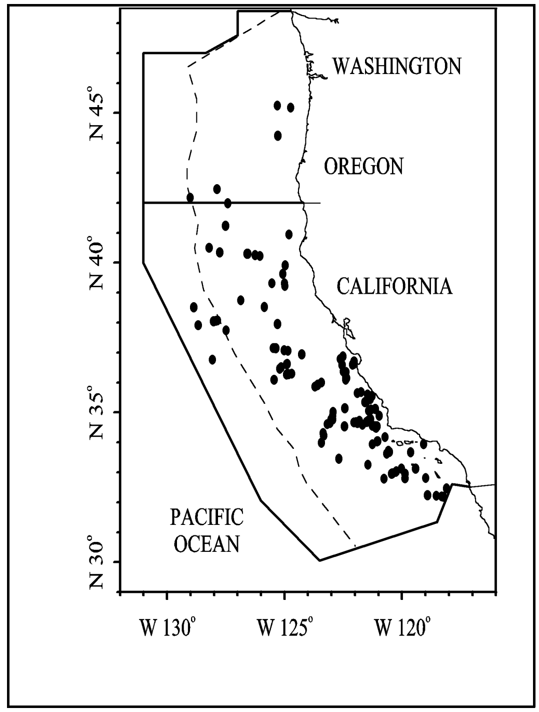

Figure 1. Fin whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1991-96 (see Appendix 2, Figures 1-5 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; bold line indicates the outer boundary of all surveys combined.

There is still insufficient information to accurately determine population structure, but from a conservation perspective it may be risky to assume panmixia in the entire North Pacific. In the North Atlantic, fin whales were locally depleted in some feeding areas by commercial whaling (Mizroch et al. 1984), in part because subpopulations were not recognized. This assessment will cover the stock of fin whales which is found along the coasts of California, Oregon, and Washington. Because fin whale abundance appears lower in winter/spring in California (Dohl et al. 1983; Forney et al. 1995) and in Oregon (Green et al. 1992), it is likely that the distribution of this stock extends seasonally outside these coastal waters. Coincidentally, fin whale abundance in the Gulf of California increases seasonally in winter and spring (Tershy et al. 1993). It is premature, however, to conclude that the Gulf whales are part of the U.S. west coast population. The Marine Mammal Protection Act (MMPA) stock assessment reports recognize three stocks of fin whales in the North Pacific: 1) the California/Oregon/Washington stock (this report), 2) the Hawaii stock, and 3) the Alaska stock.

POPULATION SIZE

The initial pre-whaling population of fin whales in the North Pacific was estimated to be 42,000-45,000 (Ohsumi and Wada 1974). In 1973, the North Pacific population was estimated to have been reduced to 13,620-18,680 (Ohsumi and Wada 1974), of which 8,520-10,970 were estimated to belong to the eastern Pacific stock. A minimum of 148 individually-identified fin whales are found in the Gulf of California (Tershy et al. 1990). Recently, ~~1,236 (CV=0.20)~~ 1,851 (CV=0.19) fin whales were estimated to be off California, Oregon and Washington based on ship surveys in summer/autumn of ~~1991, 1993, and 1996 (Barlow 1997)~~ 1993 and 1996 (Barlow, in press). This is probably a slight underestimate because it almost certainly excludes some fin whales which could not be identified in the field and which were recorded as "unidentified rorqual" or "unidentified large whale". ~~Fin whale abundance in California was estimated as only 49 (CV=1.0) based on aerial surveys in winter/spring of 1991/92 (Forney et al. 1995); however,~~

~~this estimate does not include a correction for diving animals that were missed.~~

Minimum Population Estimate

The minimum population estimate for fin whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from summer/fall ship survey (Barlow ~~1997~~, in press) or approximately ~~1,044~~ 1,581.

Current Population Trend

There is some indication that fin whales have increased in abundance in California coastal waters between 1979/80 and 1991 (Barlow 1994) and between 1991 and 1996 (Barlow 1997), but these trends are not significant. Although the population in the North Pacific is expected to have grown since receiving protected status in 1976, the possible effects of continued unauthorized take (Yablokov 1994) and incidental ship strikes and gillnet mortality make this uncertain.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of fin whale populations in the North Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~1,044~~ 1,581) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of ~~2.1~~ 3.2.

HUMAN CAUSED MORTALITY

Historic Whaling

Approximately 46,000 fin whales were taken from the North Pacific by commercial whalers between 1947 and 1987 (C. Allison, IWC, pers. comm.), including 1,060 fin whales taken by coastal whalers in central California between 1958 and 1965 (Rice 1974). In addition, approximately 3,800 were taken off the west coast of North America between 1919 and 1929 (Tonnessen and Johnsen 1982), and 177 were taken by coastal whalers off California between 1919 and 1926 (Clapham et al. 1997). Fin whales in the North Pacific were given protected status by the IWC in 1976.

Fisheries Information

The offshore drift gillnet fishery is the only fishery that is likely to take fin whales from this stock, ~~but no fishery mortalities or serious injuries have~~ and one fin whale death has been observed (Table 1). Detailed information on this fishery is provided in Appendix 1 of Forney et al. (2000). After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 1999). Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes for this fishery (Table 1) are based only on ~~1997-98~~ 1997-99 data. This results in an average estimate of ~~zero~~ 1.5 fin whales taken annually. Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net; however, fishermen report that large rorquals (blue and fin whales) usually swim through nets without entangling and with very little damage to the nets.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California and may take animals from the same population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2,700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fisheries. There are currently efforts underway to convert the Mexican swordfish driftnet fishery to a longline fishery (D. Holts, pers. comm.).

Table 1. Summary of available information on the incidental mortality and injury of fin whales (CA/OR/WA stock) for commercial fisheries that might take this species (Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999, 2000). ~~Mean annual takes are based on 1994-98 data unless noted otherwise.~~

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~1994-98~~ 1995-99	observer data	12-23%	~~0,~~0,0,0,0,1	~~0,~~0,0,0,0,4.5	~~0†~~ 1.5 [1]
Average annual takes						~~0~~ 1.5

[1] Only ~~1997-98~~ 1997-99 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).

Ship Strikes

Ship strikes were implicated in the deaths of one fin whale in 1991, one in 1996, and one in 1997 (J. Heyning and J. Cordaro, Southwest Region, NMFS, pers. comm.). Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. The average observed annual mortality due to ship strikes is 0.4 fin whales per year for the period ~~1994-98~~ 1995-99.

STATUS OF STOCK

Fin whales in the entire North Pacific were estimated to be at less than 38% (16,625 out of 43,500) of historic carrying capacity (Mizroch et al. 1984). The initial abundance has never been estimated separately for the "west coast" stock, but this stock was also probably depleted by whaling. Fin whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the California to Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The total incidental mortality due to fisheries (~~0.0~~ 1.5/yr) and ship strikes (0.4/yr) appears to be less than the calculated PBR (~~2.1~~ 3.2). ~~In fact, no fin whale mortality has been associated with California gillnet fisheries; therefore, total~~ Total fishery mortality is greater than 10% of PBR and, therefore, may not be approaching zero mortality and serious injury rate. There is some indication that the population may be growing. The increasing levels of anthropogenic noise in the world's oceans has been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound.

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FALSE KILLER WHALE (*Pseudorca crassidens*): Hawaiian Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

False killer whales are found worldwide mainly in tropical and warm-temperate waters (Stacey et al. 1994). In the North Pacific, this species is well known from southern Japan, Hawaii, and the eastern tropical Pacific. It occurs around all the main Hawaiian Islands, but its presence around the Northwestern Hawaiian Islands has not yet been established (Nitta and Henderson 1993). Recent sighting locations around the main Hawaiian Islands (Mobley et al. 2000) are shown in Figure 1. There are only 4 stranding records from Hawaiian waters (Nitta 1991). Large numbers of false killer whales have been taken in direct fisheries in southern Japan, and small numbers have been taken incidental to fishing operations in the eastern tropical Pacific. Most knowledge about this species comes from outside Hawaiian waters (Stacey et al. 1994). For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands.

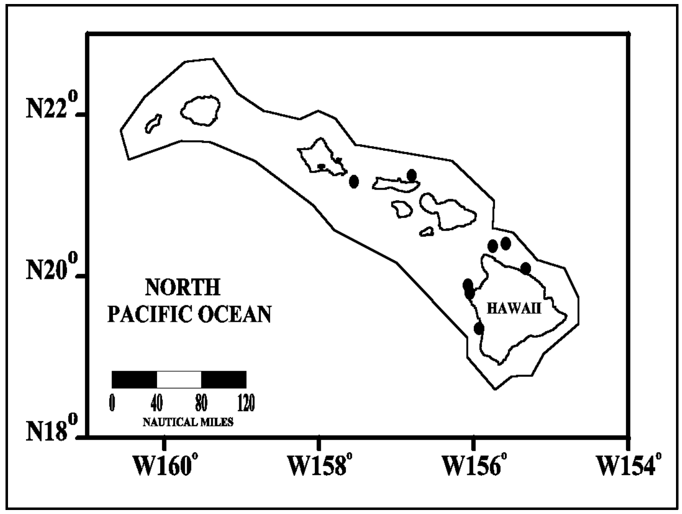

Figure 1. False killer whale sighting locations during 1993-98 aerial surveys within about 25 nmi of the main Hawaiian Islands (see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area.

POPULATION SIZE

Population estimates for this species have been made from shipboard surveys in Japan (Miyashita 1993) and the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether these animals are part of the same population that occurs around the Hawaiian Islands. As part of the Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) study, a total of twelve aerial surveys were conducted within about 25 nmi of the main Hawaiian Islands in 1993, 1995 and 1998. An abundance estimate of 121 (CV=0.47) false killer whales was recently calculated from the combined survey data (Mobley et al. 2000). This abundance underestimates the total number of false killer whales within the U.S. EEZ off Hawaii, because areas around the Northwest Hawaiian Islands (NWHI) and beyond 25 nautical miles from the main islands were not surveyed.

Minimum Population Estimate

The log-normal 20th percentile of the combined 1993-98 abundance estimate is 83 false killer whales. As with the best abundance estimate above, this includes only areas within about 25 nmi of the main Hawaiian Islands and is therefore an underestimate.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (83) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 0.8 false killer whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Although little is known about incidental mortality of false killer whales in Hawaiian waters (Nitta and Henderson 1993), ~~No estimate of annual human-caused mortality and serious injury is available as there are no reports of direct or incidental takes of false killer whales in Hawaiian waters (Nitta and Henderson 1993). However,~~ mortality of other cetacean species has been observed in Hawaiian fisheries, and the gear types used in these fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets are used in Hawaiian waters and appear to capture marine mammals wherever they are used, and float lines from lobster traps and longlines can be expected to occasionally entangle whales (Perrin et al. 1994).

Interactions with cetaceans have been reported for all Hawaiian pelagic fisheries, and false killer whales have been identified in fishermen's logs as taking catches from pelagic longlines (Nitta and Henderson 1993). They have also been observed feeding on mahi mahi, *Coryphaena hippurus*, and yellowfin tuna, *Thunnus albacares*, and frequently steal large fish (up to 70 pounds) (Shallenberger 1981) from the trolling lines of both commercial and recreational fishermen (S. Kaiser, pers. comm.).

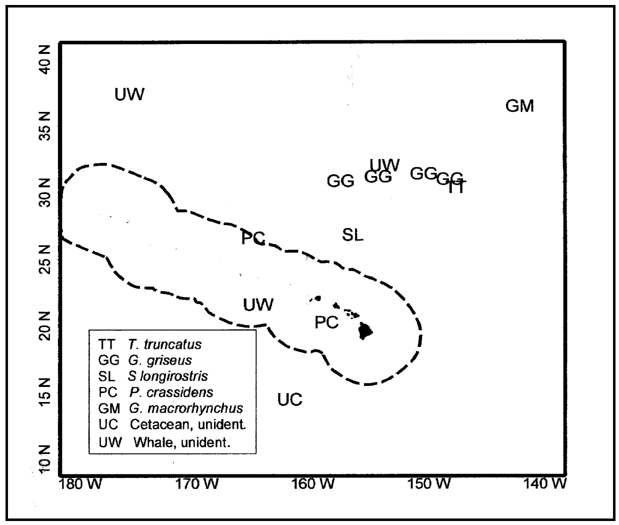

Figure 2. Locations of observed cetacean interactions in the Hawaiian longline fishery, 1994-98 (modified from Kleiber 1999). Dashed line is the U.S. Exclusive Economic Zone (EEZ); PC = false killer whale.

Two false killer whales were observed hooked in the Hawaiian longline fishery between 1994 and 1998 within the U.S. EEZ (Figure 2), with approximately 4.4% of all effort (measured as the number of hooks fished) observed. This interaction rate extrapolates to a total 5-year estimate of 45 (95% CI = 7-146) false killer whales, or an average of 9 interactions per year (Kleiber 1999). Both of the observed false killer whales were reported to have been hooked in the mouth or to have ingested the hook, and they were released with trailing gear. There were no longline fishery interactions with false killer whales reported during 1999-2000. Reports for other odontocetes indicate they may also become hooked in other parts of their body, and that they may occasionally become entangled in the fishing line. Following the guidelines of a 1997 Serious Injury Workshop (Angliss and DeMaster 1998), the two observed false killer whales have been considered seriously injured (defined under the MMPA as likely to result in mortality), and, therefore, the interaction rate of 9 animals per year represents an estimate of mortality and serious injury for this stock. Because of concern over incidental mortality of turtles and seabirds, the Hawaiian longline fishery is presently under a court order restricting effort and excluding fishing effort from a large area north of the Hawaiian Islands. This court order will expire when the National Marine Fisheries Service issues a final Environmental Impact Statement for the fishery, in early 2001. Observer coverage of this fleet has been increased in recent months, and overall fishing effort has decreased. This decrease in effort should reduce the likelihood of interactions with cetaceans, including false killer whales, unless the remaining effort is concentrated in areas where interactions are more likely. The two previously documented interactions with false killer whales were within 200 nmi of the Hawaiian Islands, but insufficient data are available to evaluate whether this is a meaningful pattern. Further changes in the longline fishery are likely in the near future, but potential effects of these changes on cetacean interactions are unknown.

Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins who steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether false killer whales are involved.

Other Removals

Since the early 1960's, at least 12 false killer whales have been live-captured by aquaria or the Navy (Pryor 1975; Shallenberger 1981; J. Thomas pers. comm.).

STATUS OF STOCK

The status of false killer whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. Because the rate of serious injury to false killer whales within the U.S. EEZ in the Hawaiian longline fishery (9 animals per year) exceeds the PBR (0.8), this stock is considered a strategic stock under the 1994 amendments to the MMPA. The total fishery mortality and serious injury cannot be considered to be insignificant and approaching zero, because it exceeds the PBR. However, the available abundance estimate, on which PBR is based, applies only to a portion of this species' range in Hawaiian waters, and additional studies of abundance, distribution, and fishery-related mortality and injury of false killer whales in Hawaiian waters will be required to re-evaluate this species' status in the future.

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APPENDIX 1 (revised 4/26/2001)

CHRONOLOGY OF U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS, 1995-2001.
Key: X = Revised with new information; R = Reprinted without revision, N = New stock, E = Eliminated stock, Shading indicates that a stock was not defined for that year.

U.S. PACIFIC MARINE MAMMAL STOCK	1995	1996	1998[1]	1999	2000	2001
PINNIPEDS						
CALIFORNIA SEA LION (*Zalophus californianus californianus*): U.S. Stock	X	X			X	R
HARBOR SEAL (*Phoca vitulina richardsi*): California Stock	X	X			X	X
HARBOR SEAL (*Phoca vitulina richardsi*): Oregon & Washington Coastal Waters Stock	X	X	X		X	R
HARBOR SEAL (*Phoca vitulina richardsi*): Washington Inland Waters Stock	X	X	X		X	R
NORTHERN ELEPHANT SEAL (*Mirounga angustirostris*): California Breeding Stock	X	X			X	R
GUADALUPE FUR SEAL (*Arctocephalus townsendi*)	X	R			X	R
NORTHERN FUR SEAL (*Callorhinus ursinus*): San Miguel Island Stock	X	X	X		X	R
HAWAIIAN MONK SEAL (*Monachus schauinslandi*)	X	X		X	X	X
CETACEANS - U. S. WEST COAST						
HARBOR PORPOISE (*Phocoena phocoena*): Central California Stock	X	X		X	X	X
HARBOR PORPOISE (*Phocoena phocoena*): Northern California Stock	X	X		X	X	X
HARBOR PORPOISE (*Phocoena phocoena*): Oregon/Washington Coast Stock	X	X	X	X	X	R
HARBOR PORPOISE (*Phocoena phocoena*): Washington Inland Waters Stock	X	X	X	X	X	R
DALL'S PORPOISE (*Phocoenoides dalli*): California/Oregon/Washington Stock	X	X			X	R
PACIFIC WHITE-SIDED DOLPHIN (*Lagenorhynchus obliquidens*): California/ Oregon/Washington, Northern and Southern Stocks	X	X			X	R
RISSO'S DOLPHIN (*Grampus griseus*): California/Oregon/Washington Stock	X	X			X	R
BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California Coastal Stock	X	X			X	X
BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California/Oregon/Washington Offshore Stock	X	X			X	R

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U.S. PACIFIC MARINE MAMMAL STOCK	1995	1996	1998[1]	1999	2000	2001
STRIPED DOLPHIN (*Stenella coeruleoalba*): California/Oregon/Washington Stock	X	X			X	R
SHORT-BEAKED COMMON DOLPHIN (*Delphinus delphis*): California/Oregon/Washington Stock	X	X			X	R
LONG-BEAKED COMMON DOLPHIN (*Delphinus capensis*): California Stock	X	X			X	R
NORTHERN RIGHT-WHALE DOLPHIN (*Lissodelphis borealis*): California/Oregon/Washington Stock	X	X			X	R
KILLER WHALE (*Orcinus orca*): California/Oregon/Washington Pacific Coast Stock	X	X		E	E	E
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Southern Resident Stock	X	X		X	X	X
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Transient Stock	(INCLUDED IN ALASKA REPORTS)			X	X	R
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Offshore Stock				N	X	R
SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): California/Oregon/Washington Stock	X	X		X	X	R
BAIRD'S BEAKED WHALE (*Berardius bairdii*): California/Oregon/Washington Stock	X	X			X	R
MESOPLODONT BEAKED WHALES (*Mesoplodon* spp.): California/Oregon/Washington Stocks	X	X	X		X	R
CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): California/Oregon/Washington Stock	X	X			X	R
PYGMY SPERM WHALE (*Kogia breviceps*): California/Oregon/Washington Stock	X	X			X	R
DWARF SPERM WHALE (*Kogia sima*): California/Oregon/Washington Stock	X	X			E	E
SPERM WHALE (*Physeter macrocephalus*): California/Oregon/Washington Stock	X	X		X	X	X
HUMPBACK WHALE (*Megaptera novaeangliae*): California/Oregon/Washington - Mexico Stock	X	X		X	X	X
BLUE WHALE (*Balaenoptera musculus*): Eastern North Pacific Stock	X	X			X	R
FIN WHALE (*Balaenoptera physalus*): California/Oregon/Washington Stock	X	X			X	X
BRYDE'S WHALE (*Balaenoptera edeni*): Eastern Tropical Pacific Stock	X	X			X	R

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U.S. PACIFIC MARINE MAMMAL STOCK	1995	1996	1998[1]	1999	2000	2001
SEI WHALE (*Balaenoptera borealis*): Eastern North Pacific Stock	X	X			X	R
MINKE WHALE (*Balaenoptera acutorostrata*): California/Oregon/Washington Stock	X	X	X		X	R
CETACEANS - HAWAII						
ROUGH-TOOTHED DOLPHIN (*Steno bredanensis*): Hawaiian Stock	X	R			X	R
RISSO'S DOLPHIN (*Grampus griseus*): Hawaiian Stock	X	R			X	R
BOTTLENOSE DOLPHIN (*Tursiops truncatus*): Hawaiian Stock	X	R			X	R
PANTROPICAL SPOTTED DOLPHIN (*Stenella attenuata*): Hawaiian Stock	X	R			X	R
SPINNER DOLPHIN (*Stenella longirostris*): Hawaiian Stock	X	R			X	R
STRIPED DOLPHIN (*Stenella coeruleoalba*): Hawaiian Stock	X	R			X	R
MELON-HEADED WHALE (*Peponocephala electra*): Hawaiian Stock	X	R			X	R
PYGMY KILLER WHALE (*Feresa attenuata*): Hawaiian Stock	X	R			X	R
FALSE KILLER WHALE (*Pseudorca crassidens*): Hawaiian Stock	X	R			X	X
KILLER WHALE (*Orcinus orca*): Hawaiian Stock	X	R			X	R
SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Hawaiian Stock	X	R			X	R
BLAINVILLE'S BEAKED WHALE (*Mesoplodon densirostris*): Hawaiian Stock	X	R			X	R
CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Hawaiian Stock	X	R			X	R
PYGMY SPERM WHALE (*Kogia breviceps*): Hawaiian Stock	X	R			X	R
DWARF SPERM WHALE (*Kogia sima*): Hawaiian Stock	X	R			X	R
SPERM WHALE (*Physeter macrocephalus*): Hawaiian Stock	X	R			X	R

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U.S. PACIFIC MARINE MAMMAL STOCK	1995	1996	1998[1]	1999	2000	2001
BLUE WHALE (*Balaenoptera musculus*): Hawaiian Stock	X	R			X	R
FIN WHALE (*Balaenoptera physalus*): Hawaiian Stock	X	R			X	R
BRYDE'S WHALE (*Balaenoptera edeni*): Hawaiian Stock	X	R			X	R
APPENDIX TITLES	**APPENDIX NUMBERS**					
Summary of Pacific Stock Assessment Reports	1	3	1	2	3	1
Description of U.S. Commercial Fisheries		1			1	
Cetacean Survey Effort		2			2	
Review of New Information for Pacific Marine Mammal Stocks			2			
Chronology of U. S. Pacific Stock Assessment Reports, 1995-1999				1	4	2
U.S. Fish and Wildlife Service California & Washington sea otter stock assessments					5	

[1]The public comment, review and revision process has necessitated about a one year time lag between the draft revision and final publication of Marine Mammal Stock Assessment Reports. Therefore, in 1997, the Stock Assessment Report dates were changed to '1998' to match the 1998 publication year of the report.

APPENDIX 2 (revised 04/26/2001)
Stocks for which new assessment reports were written in 2001 are indicated by **bold** font.

SUMMARY OF 2001 PACIFIC MARINE MAMMAL STOCK ASSESSMENT REPORTS (FOR STOCKS UNDER NMFS JURISDICTION)

Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fish. Mortality + Serious Injury	Strategic Status
California sea lion	U.S.	PAC	SWC	109,854	0.12	1.0	6,591	1,352	1,208	N
Harbor Seal	**California**	**PAC**	**SWC**	**27,962**	**0.12**	**1.0**	**1,678**	~~≥ 39~~ ≥ 714	~~n/a~~ 666	**N**
Harbor Seal	Oregon/ Washington Coast	PAC	AKC	24,705	0.12	1.0	1,482	≥ 18	≥ 16	N
Harbor Seal	Washington Inland Waters	PAC	AKC	15,174	0.12	1.0	910	≥ 43	≥ 38	N
Northern Elephant Seal	California breeding	PAC	SWC	51,625	0.083	1.0	2,142	≥ 33	≥ 33	N
Guadalupe Fur Seal	Mexico to California	PAC	SWC	3,028	0.137	0.5	104	0.0	0.0	Y
Northern Fur Seal	San Miguel Island	PAC	AKC	2,336	0.086	1.0	100	0.0	0.0	N
Monk seal	**Hawaii**	**PAC**	**SWC**	**1,436**	**0.07**	**0.1**	**5.0**~~[1]~~	**n/a**	**n/a**	**Y**
Harbor porpoise	**Central California**	**PAC**	**SWC**	~~4,172~~ **5,563**	**0.04**	**0.50**	~~42~~ **56**	~~63~~ **80**	~~63~~ **80**	**Y**
Harbor porpoise	**Northern California**	**PAC**	**SWC**	~~8,061~~ **11,054**	**0.04**	**1.0**	~~81~~ **221**	**≥ 0.2**	**≥ 0.2**	**N**
Harbor porpoise	Oregon/ Washington Coast	PAC	AKC	32,769	0.04	0.5	328	12	12	N
Harbor porpoise	Washington Inland Waters	PAC	AKC	2,545	0.04	0.4	20	15	15	N
Dall's Porpoise	California/ Oregon/ Washington	PAC	SWC	81,866	0.04	0.45	737	12	12	N
Pacific White-sided Dolphin	California/ Oregon/ Washington	PAC	SWC	17,475	0.04	0.45	157	≥ 6.8	≥ 6.8	N

[1] ~~The Endangered Species Act takes precedence in the management of this species and, under the Act, allowable take is zero.~~

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Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fish. Mortality + Serious Injury	Strategic Status
Risso's Dolphin	California/ Oregon/ Washington	PAC	SWC	13,079	0.04	0.4	105	5.5	5.5	N
Bottlenose Dolphin	**California coastal**	**PAC**	**SWC**	**~~154~~ 186**	**0.04**	**0.5**	**~~1.5~~ 1.9**	**0**	**0**	**N**
Bottlenose Dolphin	California/ Oregon/ Washington Offshore	PAC	SWC	850	0.04	0.5	8.5	0	0	N
Striped Dolphin	California/ Oregon/ Washington	PAC	SWC	17,995	0.04	0.5	180	0	0	N
Common dolphin, short-beaked	California/ Oregon/ Washington	PAC	SWC	318,795	0.04	0.5	3,188	79	79	N
Common dolphin, long-beaked	California	PAC	SWC	27,739	0.04	0.45	250	14	14	N
Northern right-whale dolphin	California/ Oregon/ Washington	PAC	SWC	10,060	0.04	0.48	97	15	15	N
Killer whale	Eastern North Pacific Transient	PAC	AKC	376	0.04	0.45	3.4	2.6	2.4	N
Killer whale	Eastern North Pacific Offshore	PAC	SWC	209	0.04	0.5	2.1	0	0	N
Killer whale	**Eastern North Pacific Southern Resident**	**PAC**	**AKC**	**~~84~~ 82**	**0.04**	**0.5**	**0.8**	**0**	**0**	**N**
Short-finned pilot whale	California/ Oregon/ Washington	PAC	SWC	717	0.04	0.4	5.7	3.0	3.0	N
Baird's Beaked Whale	California/ Oregon/ Washington	PAC	SWC	313	0.04	0.5	2.0	0	0	N

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Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fish. Mortality + Serious Injury	Strategic Status
Mesoplodont Beaked Whales	California/ Oregon/ Washington	PAC	SWC	2,734	0.04	0.5	27	0	0	N
Cuvier's Beaked Whale	California/ Oregon/ Washington	PAC	SWC	4,309	0.04	0.5	43	0	0	N
Pygmy Sperm Whale	California/ Oregon/ Washington	PAC	SWC	2,837	0.04	0.5	28	0	0	N
Sperm whale	**California/ Oregon/ Washington**	**PAC**	**SWC**	**~~995~~ 1,026**	**0.04**	**0.1**	**~~2.0~~ 2.1**	**2.5**	**2.5**	**Y**
Humpback whale	**California/ Oregon/ Washington**	**PAC**	**SWC**	**~~861~~ 944**	**0.04**	**0.1**	**~~1.7~~ 1.9**	**1.4**	**1.2**	**Y**
Blue whale	Eastern North Pacific	PAC	SWC	1,716	0.04	0.1	1.7	0.0	0	Y
Fin whale	**California/ Oregon/ Washington**	**PAC**	**SWC**	**~~1,044~~ 1,581**	**0.04**	**0.1**	**~~2.1~~ 3.2**	**0.4**	**0**	**Y**
Bryde's whale	California/ Oregon/ Washington	PAC	SWC	11,163	0.04	0.5	n/a	0	0	N
Sei whale	California/ Oregon/ Washington	PAC	SWC	n/a	0.04	0.1	n/a	0	0	Y
Minke whale	California/ Oregon/ Washington	PAC	SWC	440	0.04	0.45	4.0	0	0	N
Rough-Toothed Dolphin	Hawaii	PAC	SWC	76	0.04	0.5	0.8	n/a	n/a	N
Risso's Dolphin	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
Bottlenose Dolphin	Hawaii	PAC	SWC	479	0.04	0.5	4.8	n/a	n/a	N

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Species	Stock Area	Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fish. Mortality + Serious Injury	Strategic Status
Pantropical spotted dolphin	Hawaii	PAC	SWC	2,040	0.04	0.5	20	n/a	n/a	N
Spinner dolphin	Hawaii	PAC	SWC	2,355	0.04	0.5	24	n/a	n/a	N
Striped dolphin	Hawaii	PAC	SWC	52	0.04	0.5	0.5	n/a	n/a	N
Melon-headed whale	Hawaii	PAC	SWC	81	0.04	0.5	0.8	n/a	n/a	N
Pygmy killer whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
False killer whale	**Hawaii**	**PAC**	**SWC**	**83**	**0.04**	**0.5**	**0.8**	**9.0**	**9.0**	**Y**
Killer whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
Pilot whale, short-finned	Hawaii	PAC	SWC	1,313	0.04	0.5	13	n/a	n/a	N
Blainville's beaked whale	Hawaii	PAC	SWC	43	0.04	0.5	0.4	n/a	n/a	N
Cuvier's beaked whale	Hawaii	PAC	SWC	29	0.04	0.5	0.3	n/a	n/a	N
Pygmy sperm whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
Dwarf sperm whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N
Sperm whale	Hawaii	PAC	SWC	43	0.04	0.1	0.4	n/a	n/a	Y
Blue whale	Hawaii	PAC	SWC	n/a	0.04	0.1	n/a	n/a	n/a	Y
Fin whale	Hawaii	PAC	SWC	n/a	0.04	0.1	n/a	n/a	n/a	Y
Bryde's whale	Hawaii	PAC	SWC	n/a	0.04	0.5	n/a	n/a	n/a	N

n/a indicates that data are not available.